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ABSTRACT

This instructor guide and the corresponding student reference contain seven lessons about animal reproduction for inclusion in Vocational Instructional Management System (VIMS) agricultural education courses. The lessons cover the following topics: the male and female reproductive systems, puberty and the estrous cycle, conception and gestation, parturition, reproduction and genetics, and genetic improvement management practices. The instructor's guide contains the following: objectives, competencies, motivational techniques, teaching procedures, other activities, activity sheets, transparency masters, evaluations, answers to evaluations and activity sheets, 26 references and teaching aids, materials and equipment lists, and a student competency profile. The student reference consists of information sheets and illustrations for the lessons. (KC)

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Introduction To
Animal Reproduction

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Instructor Guide

In cooperation with
Agricultural Education
Department of Practical Arts and
Vocational-Technical Education
College of Education and College of Agriculture,
Food and Natural Resources
University of Missouri - Columbia

In cooperation with
Agricultural Education Section
Division of Vocational and Adult Education
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INTRODUCTION TO ANIMAL REPRODUCTION

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FOREWORD

The development of the *Introduction to Animal Reproduction* curriculum guide is the result of suggestions by the MVATA Teaching Aids Committee. The Animal Reproduction Advisory Committee suggested the topics to be included and reviewed the materials.

This curriculum contains seven lessons. The instructor's guide includes objectives, competencies, motivational techniques, teaching procedures, other activities, activity sheets, transparency masters, evaluations, answers to evaluations and activity sheets, references and teaching aids, and materials and equipment. Topics include the male and female reproductive systems, puberty and the estrous cycle, conception and gestation, parturition, reproduction and genetics, and genetic improvement management practices. One copy of the student reference is packaged with the instructor's guide. Additional copies of the student reference can be purchased separately.

During the summer of 1981, the Missouri State Board of Education formally adopted the concept of "Instructional Management Systems" (IMS) as a priority for the 1981-82 school year. The Missouri Commissioner of Education described the IMS concept as a practical way of "organizing for excellence" in education. To meet the demand for greater productivity and accountability, the director of Vocational Education applied the elements of IMS to form the Vocational Instructional Management System (VIMS). The VIMS process provides a framework to use in planning and organizing to assure excellence in Missouri's vocational education system by focusing greater attention on the management of teaching and learning.

This guide incorporates the needed components to aid agriculture teachers in the implementation of VIMS. For ease of use, objectives and competencies have been included at the beginning of the guide as well as incorporated within each lesson. A competency profile has been provided in the front of the guide for convenient record keeping.

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INTRODUCTION TO ANIMAL REPRODUCTION

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COMPETENCIES/OBJECTIVES

1. Explain the purpose of male reproductive parts and hormones.
2. Explain the purpose of female reproductive parts and hormones.
3. Explain the role of puberty and the estrous cycle in reproduction.
4. Describe conception and gestation.
5. Identify the important factors of parturition.
6. Define the role of genetics in reproduction.
7. Compare management practices for genetic improvement.

EVALUATION

1. Give short, objective tests following each lesson and a more in-depth objective test at the conclusion of the unit.
2. Observe the changes in behavior as evidence of the improved ability of students to deal with problems in this unit using backgound information acquired from earlier units.
3. Observe students' attempts to solve similar problems in their supervised agricultural experience programs.

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2. Teacher References

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    1) G2015: *Reproductive Anatomy and Physiology of the Cow*
    2) G2016: *Reproductive Anatomy and Physiology of the Bull*
    3) G2035: *Calving Difficulty in Beef Cattle*
    4) G2040: *Crossbreeding Systems for Small Herds of Beef Cattle*
    5) G2299: *Swine Pregnancy Checking by Ultrasonic Sound*
    6) G2610: *Sheep Pregnancy Checking by Ultrasonic Sound*
    7) G2791: *Genetics of Coat Color of Horses*
    8) G3000: *Fundamentals of Inheritance*
    9) G9922: *Reproductive Management of the Brood Bitch*
    10) G9923: *Pregnancy Determination in the Bitch*

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Introduction to Animal Reproduction
Competency Profile

Directions: Evaluate the student by checking the appropriate number or letter to indicate the degree of competency. The rating for each task should reflect **employability readiness** rather than the grades given in class.

Rating Scale:

3 Mastered - can work independently with no supervision
2 Requires Supervision - can perform job completely with limited supervision
1 Not Mastered - requires instruction and close supervision
N No Exposure - no experience or knowledge in this area

3	2	1	N	**Introduction to Animal Reproduction**
				1. Explain the purpose of male reproductive parts and hormones
				2. Explain the purpose of female reproductive parts and hormones
				3. Explain the role of puberty and the estrous cycle in reproduction
				4. Describe conception and gestation
				5. Identify the important factors of parturition
				6. Define the role of genetics in reproduction
				7. Compare management practices for genetic improvement
				Other: ____________________
				____________________

Introduction to Animal Reproduction

Student Names														

Competencies

1. Explain the purpose of the male reproductive parts and hormones.
2. Explain the purpose of the female reproductive parts and hormones.
3. Explain the role of puberty and the estrous cycle in reproduction.
4. Describe conception and gestation.
5. Identify the important factors of parturition.
6. Define the role of genetics in reproduction.
7. Compare management practices for genetic improvement.

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 1: Male Reproductive System

Competency/Objective: Explain the purpose of male reproductive parts and hormones.

Study Questions

1. **What are the male reproductive parts?**
2. **What are the functions/purposes of the male reproductive parts?**
3. **What are the male reproductive hormones?**
4. **What roles do each of the male hormones play in reproduction?**

References

1. *Introduction to Animal Reproduction (Student Reference).* University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
2. Transparency Masters
    - a) TM 1.1: Reproductive System of the Bull
    - b) TM 1.2: Reproductive System of the Bull (Overlay)
    - c) TM 1.3: Reproductive System of the Boar
    - d) TM 1.4: Reproductive System of Fowl - Rooster
    - e) TM 1.5: Reproductive System of the Ram
    - f) TM 1.6: Reproductive System of the Stallion
    - g) TM 1.7: Reproductive System of the Dog
    - h) TM 1.8: Reproductive System of the Rabbit
    - i) TM 1.9: Male Reproductive Hormones
3. Activity Sheets
    - a) AS 1.1: Reproductive System of the Bull
    - b) AS 1.2: Dissection of a Testicle
      NOTE: The testicle should be kept frozen until the dissection is performed.

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 1: Male Reproductive System

TEACHING PROCEDURES

A. Introduction

This book will explain reproduction, which all animals depend on for the continuation of their species. It will describe the male and female reproductive parts and their functions, the process of reproduction from puberty through conception, gestation, and birth, and the role of genes in reproduction. This lesson will discuss the male reproductive parts and their functions, as well as the reproductive role of hormones.

B. Motivation

Display a beef testicle. Ask the students what it is. Then ask the students the following questions: What is the purpose of the testicle? How does a testicle assist in producing offspring?

C. Assignment

D. Supervised Study

E. Discussion

1. Hand out AS 1.1. Label all the reproductive parts of the bull using TM 1.1. (An overlay with labels for each of the parts of the system is included in TM 1.2) Display the TMs for the swine, sheep, horse, dog, rabbit, and fowl. Discuss the differences among the species.

What are the male reproductive parts?

a) Bull reproductive parts
    1) Testicles
    2) Scrotum
    3) Epididymis
    4) Vas deferens
    5) Seminal vesicles
    6) Prostate gland
    7) Cowper's (bulbourethral) gland
    8) Urinary bladder
    9) Urethra
    10) Sigmoid flexure
    11) Retractor muscle
    12) Penis
    13) Sheath
b) Boar reproductive parts
    1) Parts similar to the bull's, but testicles located at the rear of the boar
    2) Penis shaped like a corkscrew
c) Ram reproductive parts
    1) Filiform appendage extends from head of penis
    2) Sheath also referred to as prepuce
d) Stallion reproductive parts
    1) Less pendulous scrotum located further to rear of animal

    - 2) No sigmoid flexure
- e) Dog reproductive parts
    - 1) No Cowper's gland or seminal vesicles
    - 2) No sigmoid flexure
    - 3) Sheath of penis referred to as prepuce
- f) Buck reproductive parts
    - 1) Scrotum referred to as inguinal pouch
    - 2) Sheath referred to as prepuce
    - 3) Prostate gland separated into three parts
    - 4) No Cowper's gland
    - 5) No sigmoid flexure
- g) Fowl reproductive parts
    - 1) No scrotum
    - 2) Testicles located within abdomen, next to backbone
    - 3) Vas deferens connects testicles to cloaca, papillae, and vent
    - 4) Papillae within cloaca
    - 5) No urethra or urinary bladder

2. Discuss the function and purpose of each of the reproductive parts of the bull. Explain the functions of any reproductive parts found in other species not found in the bull. Use TM 1.1 as an illustration while explaining the functions.

What are the functions/purposes of the male reproductive parts?

- a) Functions of bull reproductive parts
    - 1) Testicles - produce sperm and hormones associated with reproduction
    - 2) Scrotum - carries testicles and regulates their temperature
    - 3) Epididymis - stores, concentrates, and transports sperm
    - 4) Vas deferens - transports sperm from the epididymis to the urethra
    - 5) Urethra - carries sperm and urine to the penis
    - 6) Urinary bladder - stores urine; has no reproductive function
    - 7) Seminal vesicles - produce seminal fluid that transports and protects the sperm
    - 8) Prostate gland - nourishes the sperm with a thick, milky fluid
    - 9) Cowper's (bulbourethral) gland - releases fluid into urethra to cleanse and neutralize it to allow sperm to survive in it
    - 10) Sigmoid flexure - extends the penis outside the body during mating
    - 11) Retractor muscle - pulls the penis back into the body
    - 12) Penis - deposits semen in the female reproductive tract and excretes urine from the body
    - 13) Sheath - covers and protects the penis when it is relaxed
- b) Functions of the boar reproductive parts - the same as the bull's
- c) Functions of the ram reproductive parts - the same as the bull's; filiform appendage is an extension of the urethra
- d) Functions of the stallion reproductive parts - the same as the bull's
- e) Functions of the dog reproductive parts - the same as the bull's
- f) Functions of the buck reproductive parts - the same as the bull's
- g) Functions of the fowl reproductive parts
    - 1) Testicles - produce sperm and hormones and secrete seminal fluid
    - 2) Vas deferens - transports sperm and seminal fluid from the testicles to the cloaca
    - 3) Cloaca - the site where the reproductive and digestive systems are joined; joins the female cloaca when mating
    - 4) Papillae - transport sperm the female reproductive tract during mating
    - 5) Vent - empties reproductive and digestive products from the body

3. Ask students to explain what a hormone is. Emphasize where the various hormones originate. Use TM 1.9 to discuss hormones in all species except fowl.

   What are the male reproductive hormones?

   a) Gonadotrophin releasing hormone (GnRH); not present in fowl
   b) Follicle stimulating hormone (FSH)
   c) Luteinizing hormone (LH), also known as interstitial cell stimulating hormone (ICSH)
   d) Androgens - testosterone; another androgen produced in rabbits

4. Discuss the importance of male hormones in reproduction. Point out that each hormone has a role and that together they are in a delicate balance. Emphasize that hormones are the reason successful reproduction occurs. Continue to use TM 1.9 while discussing each hormone.

   What roles do each of the male hormones play in reproduction?

   a) GnRH - stimulates the anterior pituitary gland in the brain to release FSH and LH, except in fowl, in which FSH production in fowl triggered by increased light
   b) FSH - stimulates the seminiferous tubules to produce sperm
   c) LH - stimulates the interstitial cells to secrete androgens
   d) Androgens (testosterone) - stimulate the development, growth, and activity of reproductive parts; trigger puberty and the development of secondary sex characteristics; stimulate sex drive; function in the production of sperm

F. Other Activities

Contact a local veterinarian to obtain a male reproductive tract from any animal species. Do a dissection, identifying and explaining all the male reproductive parts.

G. Conclusion

Reproduction is vital for the survival of each species. Male reproductive parts and hormones have specific and important roles in reproduction.

H. Answers to Activity Sheets

AS 1.1

1. Prostate gland
2. Seminal vesicles
3. Cowper's (bulbourethral) gland
4. Urinary bladder
5. Retractor muscle
6. Vas deferens
7. Urethra
8. Penis
9. Sigmoid flexure
10. Sheath
11. Testicle
12. Epididymis
13. Scrotum

AS 1.2

1. Head of the epididymis
2. Seminiferous tubules
3. Sperm is produced in the seminiferous tubules of the testicle. The sperm move from the seminiferous tubules through the head, body, and tail of the epididymis and enter the vas deferens from the testicle.

I. Answers to Evaluation

1. Seminal vesicles
2. Vas deferens
3. Prostate gland
4. Cowper's (bulbourethral) gland
5. Urinary bladder
6. Retractor muscle
7. Urethra
8. Testicle
9. Sigmoid flexure
10. Epididymis
11. Penis
12. Scrotum
13. Sheath
14. i
15. h
16. k
17. g
18. j
19. f
20. d
21. a
22. d
23. b
24. c

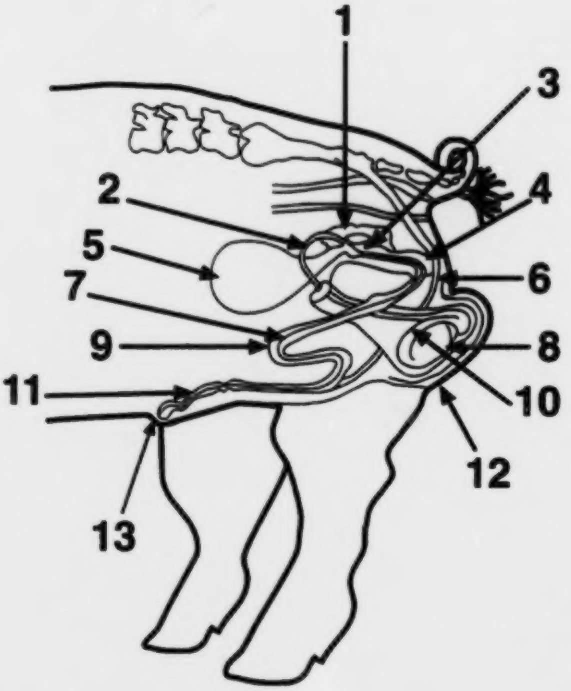
UNIT - INTRODUCTION TO ANIMAL REPRODUCTION Name______________________________

Lesson 1: Male Reproductive System Date______________________________

EVALUATION

Using the numbered diagram, fill in the name of the reproductive part of the boar on the blank provided next to the correct number.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________
11. ______________________________
12. ______________________________
13. ______________________________



Match the terms on the right with the best definition.

14. _____ Site where reproductive hormones are produced
15. _____ Muscle that extends the penis out of the body
16. _____ Carries sperm from the epididymis
17. _____ An enclosed sac that regulates the temperature of the testicles
18. _____ Transports semen and urine to the penis
19. _____ Secretes a fluid to transport and protect the sperm

a. Cowper's gland
b. Epididymis
c. Penis
d. Prostate gland
e. Retractor muscle
f. Seminal vesicles
g. Scrotum
h. Sigmoid flexure
i. Testicles
j. Urethra
k. Vas deferens

Circle the letter that corresponds to the best answer.

20. Which hormone stimulates the testicles to produce testosterone?

    a. Estrogen
    b. Follicle stimulating hormone (FSH)
    c. Gonadotrophin releasing hormone (GnRH)
    d. Luteinizing hormone (LH)

21. Which hormone triggers puberty?

    a. Follicle stimulating hormone (FSH)
    b. Gonadotrophin releasing hormone (GnRH)
    c. Luteinizing hormone (LH)
    d. Testosterone

22. Which of the following is not a secondary sex characteristic?

    a. Aggressiveness
    b. A deep voice
    c. Heavily muscled neck and shoulders
    d. The sex drive

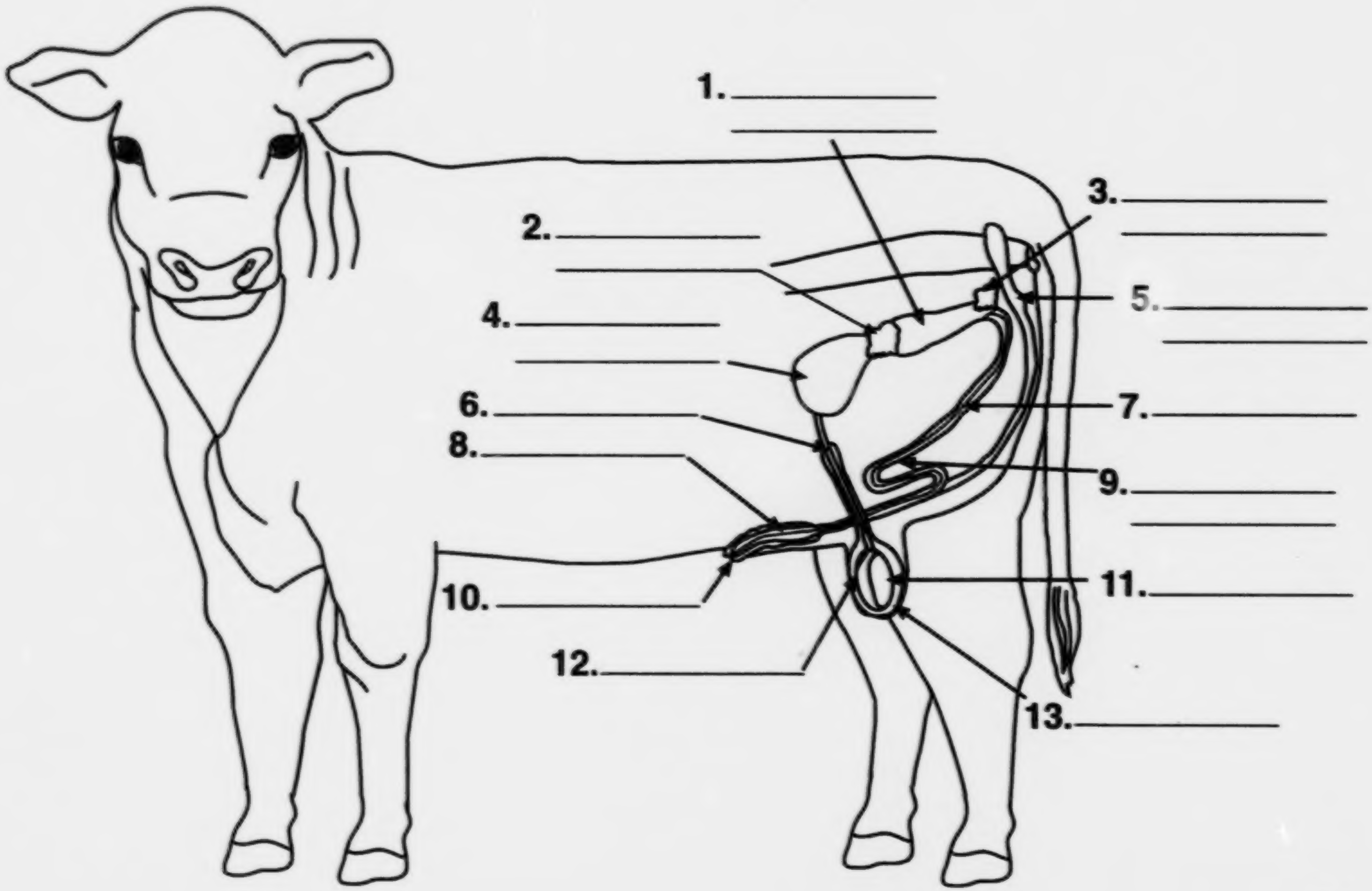
23. Which hormone stimulates the pituitary gland to release essential reproductive hormones?

    a. Follicle stimulating hormone (FSH)
    b. Gonadotrophin releasing hormone (GnRH)
    c. Luteinizing hormone (LH)
    d. Testosterone

24. Which hormone causes the release of androgens?

    a. FSH
    b. GnRH
    c. LH
    d. Testosterone

Reproductive System of the Bull


1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.

TM 1.1

Reproductive System of the Bull (Overlay)

Prostate
Gland

Cowper's
Gland

Seminal
Vesicles

Retractor
Muscle

Urinary
Bladder

Vas Deferens

Urethra

Penis

Sigmoid
Flexure

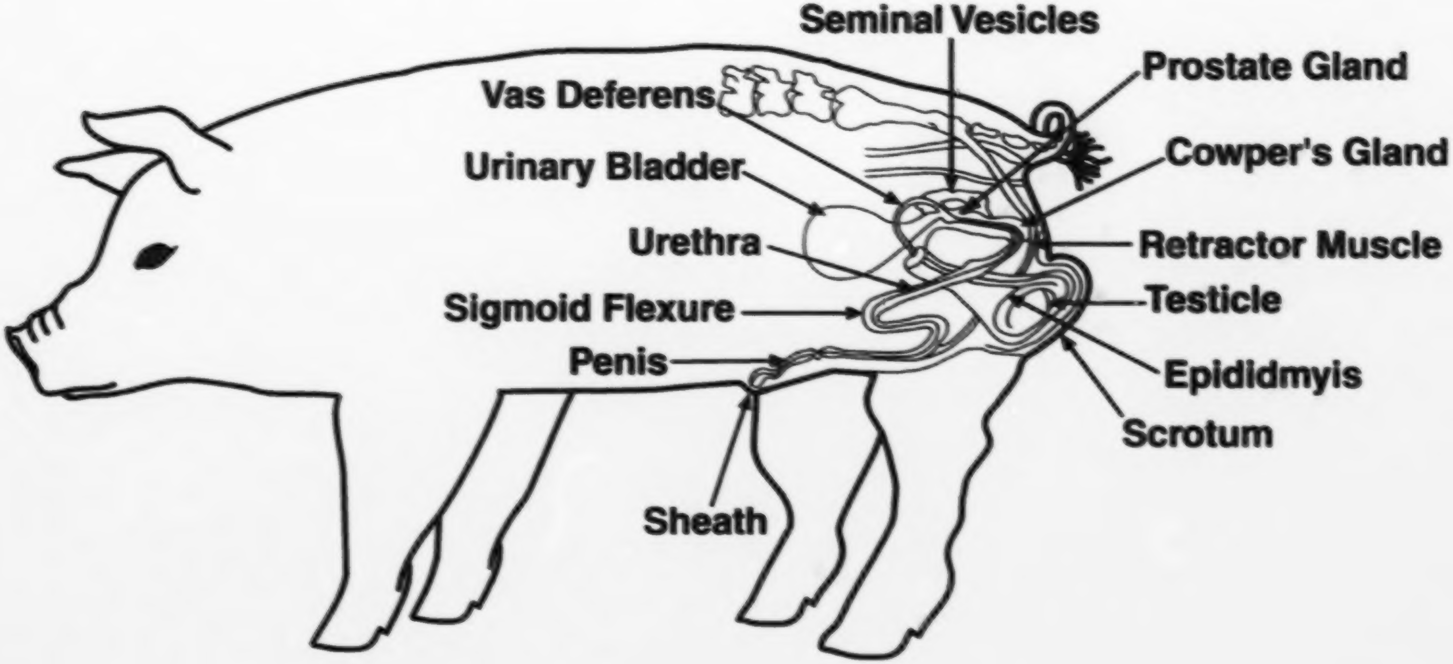
Testicle

Sheath

Epididymis

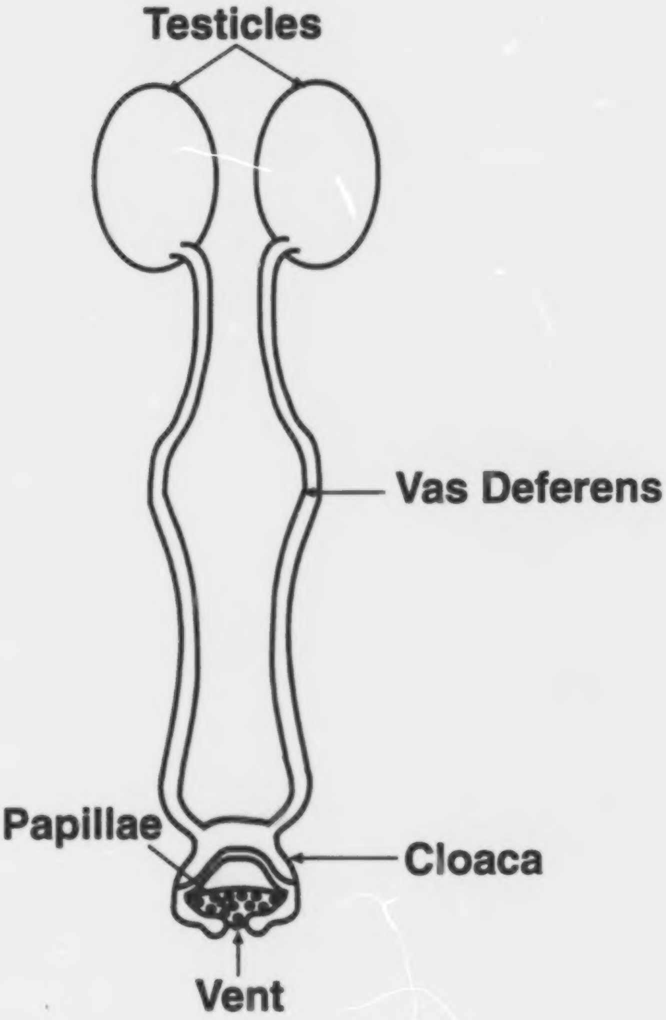
Scrotum

Reproductive System of the Boar


Seminal Vesicles
Prostate Gland
Vas Deferens
Cowper's Gland
Urinary Bladder
Retractor Muscle
Urethra
Testicle
Sigmoid Flexure
Penis
Epididmyis
Scrotum
Sheath

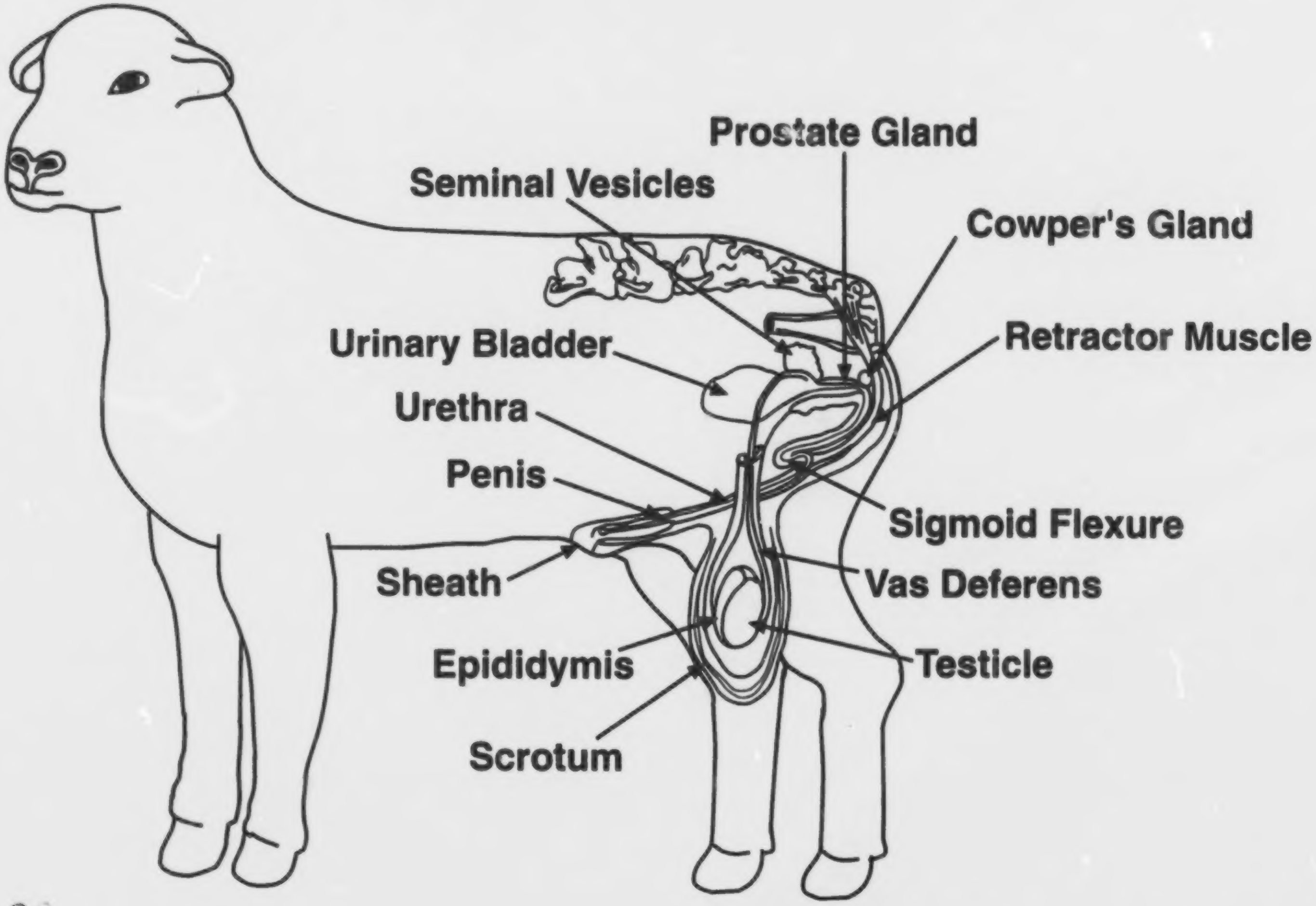
TM 1.3

Reproductive System of Fowl - Rooster


Testicles
Vas Deferens
Papillae
Cloaca
Vent

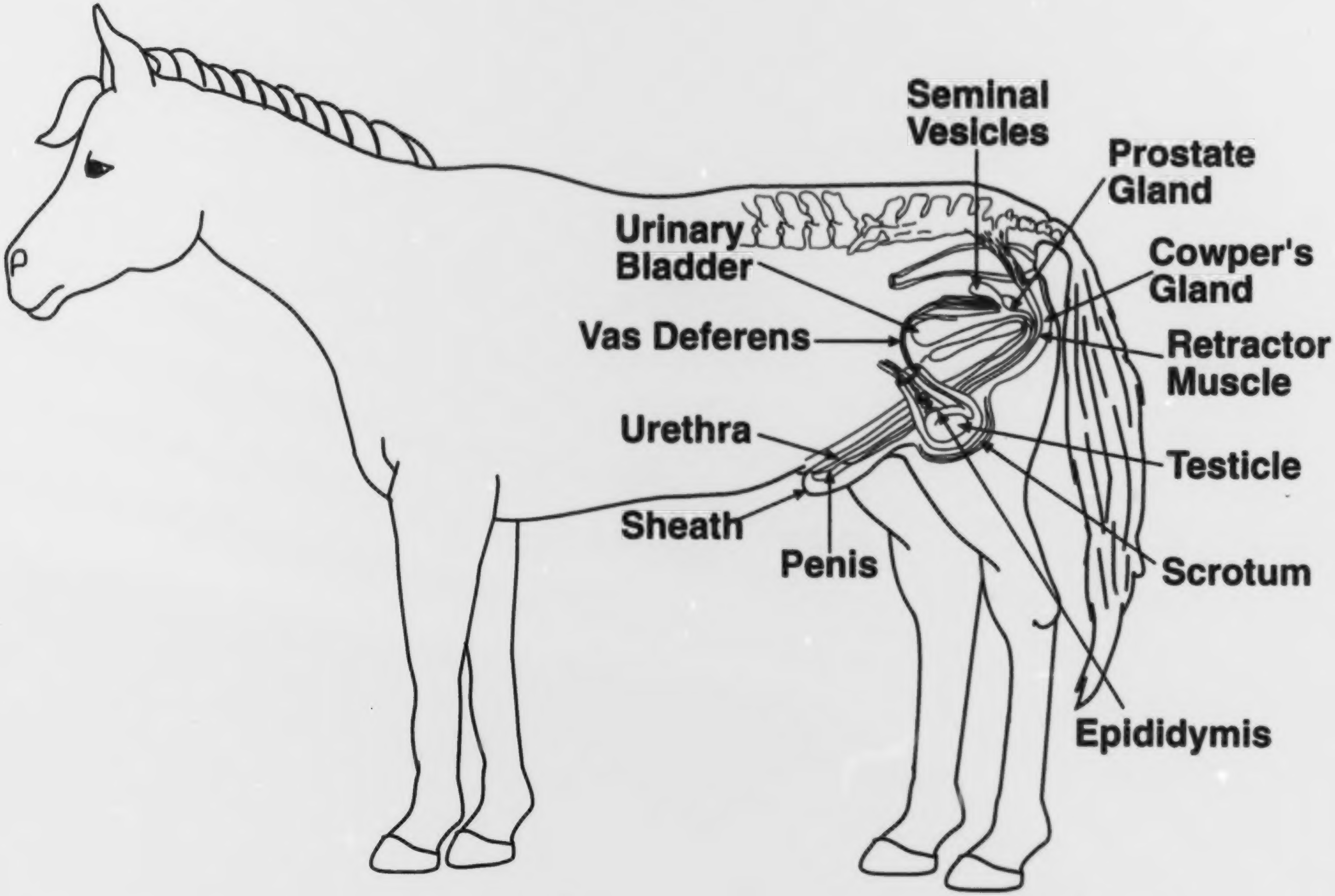
27

Reproductive System of the Ram


Prostate Gland
Seminal Vesicles
Cowper's Gland
Urinary Bladder
Retractor Muscle
Urethra
Penis
Sigmoid Flexure
Sheath
Vas Deferens
Epididymis
Testicle
Scrotum

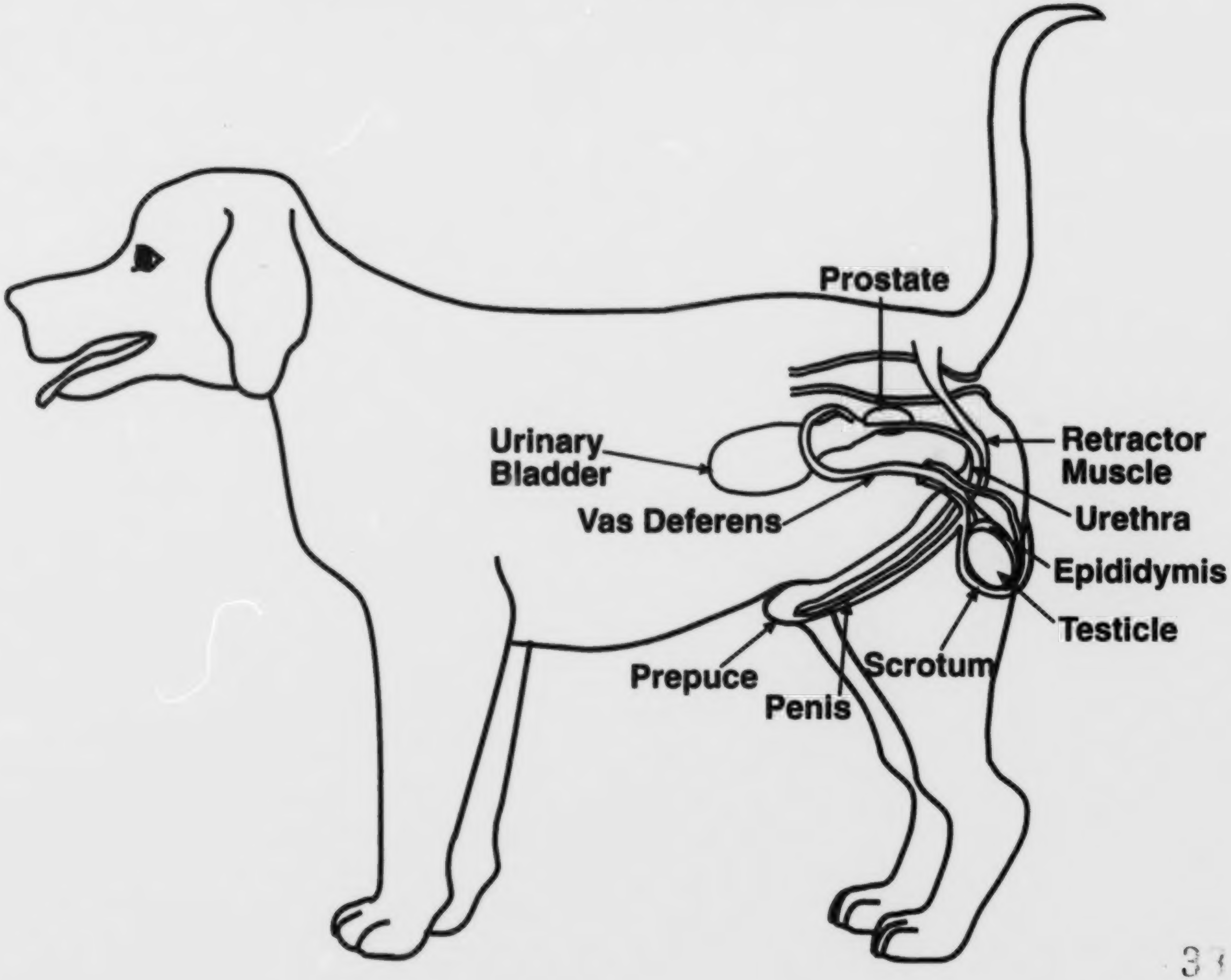
TM 1.5

Reproductive System of the Stallion


Seminal Vesicles
Prostate Gland
Urinary Bladder
Cowper's Gland
Vas Deferens
Retractor Muscle
Urethra
Testicle
Sheath
Penis
Scrotum
Epididymis

TM 1.6

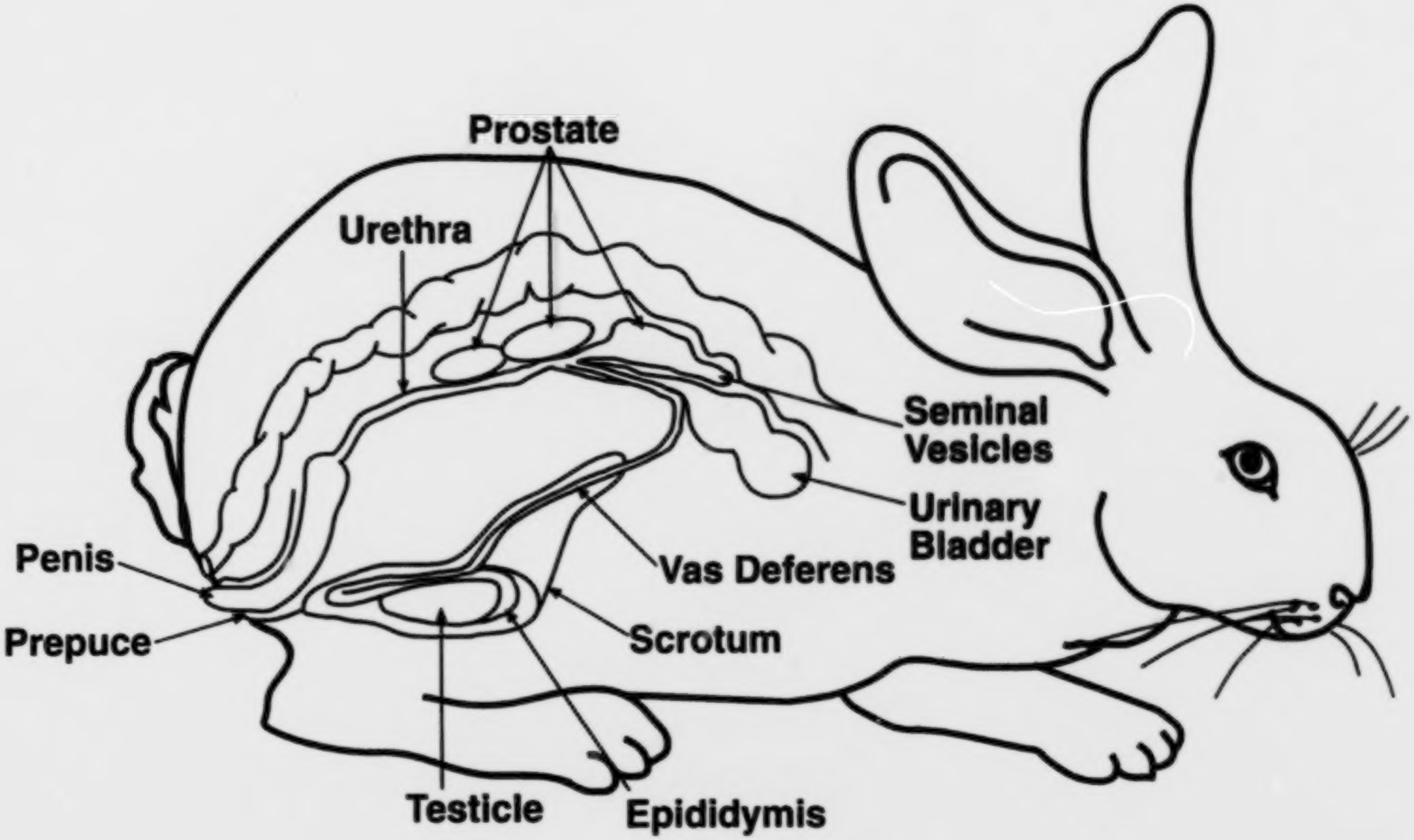
Reproductive System of the Dog


Prostate
Urinary Bladder
Retractor Muscle
Vas Deferens
Urethra
Epididymis
Testicle
Scrotum
Prepuce
Penis

33

32

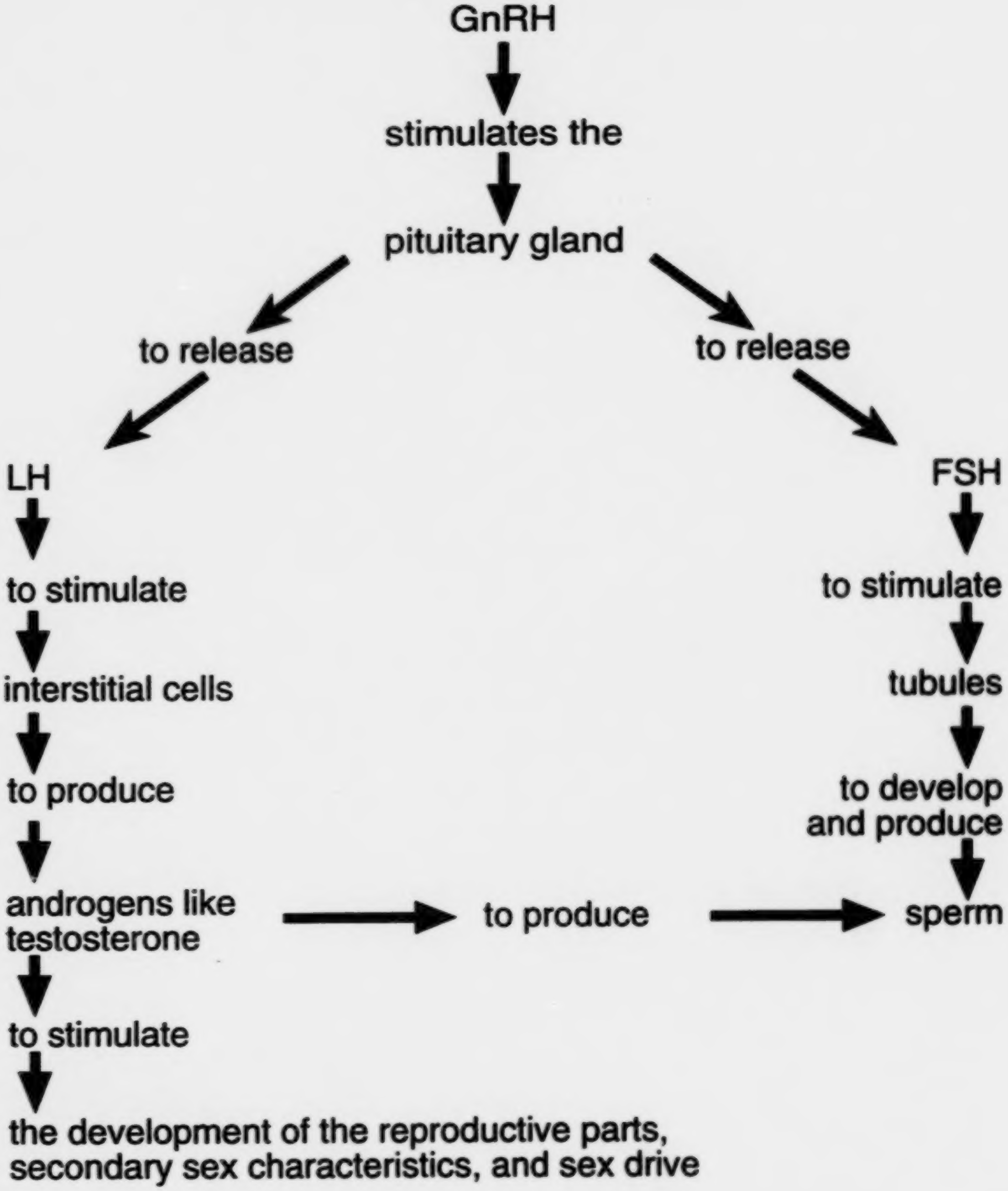
Reproductive System of the Rabbit


Prostate
Urethra
Seminal Vesicles
Urinary Bladder
Vas Deferens
Penis
Prepuce
Scrotum
Testicle
Epididymis

TM 1.8

TM 1.9

Male Reproductive Hormones



GnRH

stimulates the

pituitary gland

to release

LH

to stimulate

interstitial cells

to produce

androgens like testosterone

to stimulate

the development of the reproductive parts, secondary sex characteristics, and sex drive

to release

FSH

to stimulate

tubules

to develop and produce

sperm

androgens like testosterone → to produce → sperm

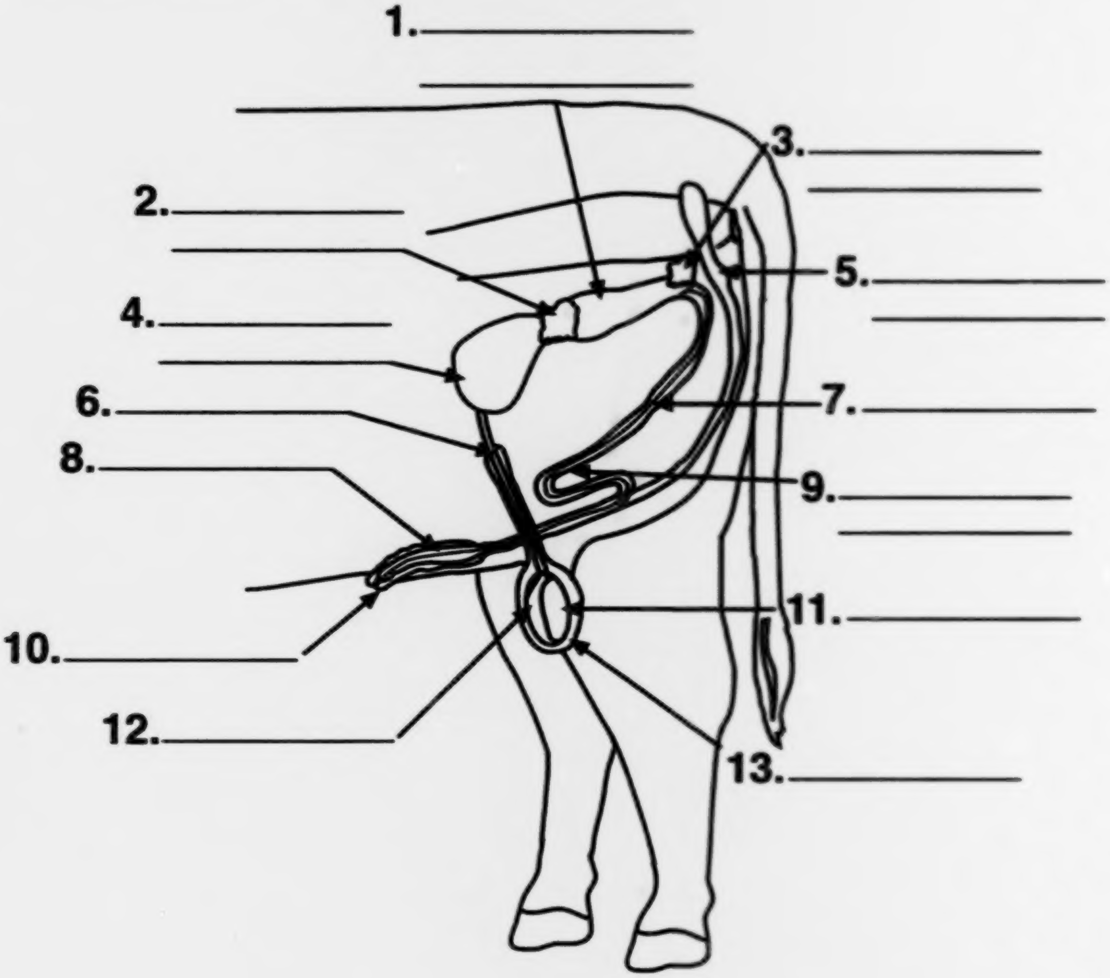
UNIT - INTRODUCTION TO ANIMAL REPRODUCTION AS 1.1

Lesson 1: Male Reproductive System Name______________________________

Reproductive System of the Bull

Objective: Identify the parts of the reproductive system of the bull.

Label the parts of the reproductive system.



Lesson 1: Male Reproductive System

Name____________________________

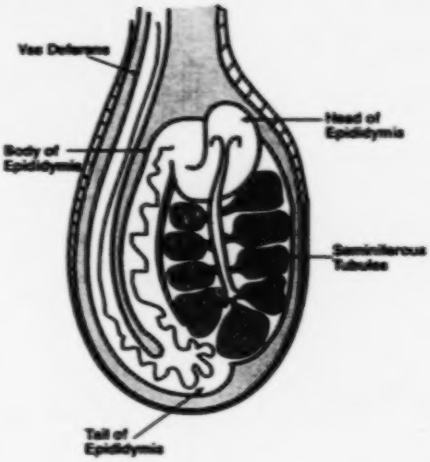
Dissection of a Testicle

Objective: Identify the parts of the testicle in a lab dissection experiment.

Activity Length: 30 minutes

Materials and Equipment:

Castrated beef testicle (large enough to dissect)
Dissecting knife
Lab coat
Lab gloves (palpation sleeves may also be used)



Procedure:

1. Before beginning the dissection, put on the lab coat and gloves.

2. Using a knife, cut the testicle at the point where the vas deferens ends and the epididymis begins. Set aside the vas deferens.

3. Separate the epididymis and the body of seminiferous tubules with the knife.

4. Cut the epididymis between the tail and body and set the tail section aside. Next, cut the remainder of the epididymis between the body and the head.

Key Questions:

1. Which part of the epididymis is attached to the body of seminiferous tubules?

2. In which part of the testicle does sperm originate?

3. What is the path taken by sperm within the testicle?

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 2: Female Reproductive System

Competency/Objective: Explain the purpose of female reproductive parts and hormones.

Study Questions

1. **What are the female reproductive parts?**
2. **What are the functions/purposes of the female reproductive parts?**
3. **What are the female reproductive hormones?**
4. **What role does each of the female hormones play in reproduction?**

References

1. *Introduction to Animal Reproduction (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
2. Transparency Masters
   - a) TM 2.1: Reproductive System of the Cow - Top View
   - b) TM 2.2: Reproductive System of the Cow - Top View (Overlay)
   - c) TM 2.3: Reproductive System of the Cow - Side View
   - d) TM 2.4: Reproductive System of the Sow - Top View
   - e) TM 2.5: Reproductive System of the Sow - Side View
   - f) TM 2.6: Reproductive System of Fowl - Hen
   - g) TM 2.7: Reproductive System of the Ewe
   - h) TM 2.8: Reproductive System of the Mare
   - i) TM 2.9: Reproductive System of the Bitch
   - j) TM 2.10: Reproductive System of the Doe
   - k) TM 2.11: Hormone Cycle
3. Activity Sheet
   - a) AS 2.1: Reproductive System of the Cow
   - b) AS 2.2: Dissection of a Female Reproductive Tract
     NOTE: A female reproductive tract can be obtained from a processing plant or veterinarian. It should be kept frozen until the dissection is performed.

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 2: Female Reproductive System

TEACHING PROCEDURES

A. Review

Lesson 1 covered the male reproductive parts and hormones for various species. In this lesson, the female reproductive parts and their functions, as well as the role of reproductive hormones, will be discussed for each of those species.

B. Motivation

Display a reproductive tract to be used for the dissection in AS 2.2. Ask students if they can identify the different parts of the reproductive tract.

C. Assignment

D. Supervised Study

E. Discussion

1. Hand out AS 2.1. Label all the reproductive parts of the cow using TM 2.1. (An overlay with labels is provided in TM 2.2.) Display the TMs for the other species (TM 2.2 to 2.10) and discuss any differences.

What are the female reproductive parts?

a) Cow reproductive parts
   1) Ovaries
   2) Infundibulum
   3) Oviducts (also called fallopian tubes)
   4) Uterus
   5) Uterine horns
   6) Cervix
   7) Vagina
   8) Urinary bladder
   9) Urethra
   10) Clitoris
   11) Vulva

b) Sow reproductive parts
   1) Uterine horns more prominent
   2) Cervix with protruding areas rather than folds as in the cow

c) Ewe reproductive parts - very similar to the cow's

d) Mare reproductive parts - smoother cervix without folds like the cow's

e) Bitch reproductive parts - more prominent uterine horns than the cow

f) Doe reproductive parts
   1) Prominent uterine horns
   2) Two cervices

g) Fowl reproductive parts
   1) Only the left ovary and oviduct are functional
   2) Oviduct with five parts - infundibulum, magnum, isthmus, uterus, and vagina

    3) Cloaca
    4) Vent

2. Discuss how each part of the female reproductive system works. Use TM 2.1 to guide the discussion on the functions of the cow's reproductive parts. Discuss any differences among the species.

What are the functions/purposes of the female reproductive parts?

- a) Functions of the cow's reproductive parts
    - 1) Ovary - produces ova (eggs) and female sex hormones
    - 2) Infundibulum - receives the egg from the ovary
    - 3) Oviduct - carries the egg from the ovary to uterus and is the site of fertilization
    - 4) Uterus - location of the development of the fertilized egg
    - 5) Uterine horns - the part of the uterus where the fertilized egg attaches and the fetus develops; litter-bearing animals have more pronounced uterine horns
    - 6) Cervix - acts as a passageway to the uterus for sperm and keeps foreign material out during pregnancy by forming a waxy mucus plug; also acts as a part of the birth canal
    - 7) Vagina - the site through which male semen is deposited into the female reproductive system, as well as a part of the birth canal and the passageway for urine
    - 8) Urinary bladder - stores urine; has no reproductive function
    - 9) Urethra - carries urine to the vagina from the bladder; has no reproductive function
    - 10) Clitoris - stimulated during mating
    - 11) Vulva - external opening to the vagina
- b) Functions of the sow's reproductive parts - the same as the cow's
- c) Functions of the ewe's reproductive parts - the same as the cow's
- d) Functions of the mare's reproductive parts - the same as the cow's
- e) Functions of the reproductive parts of the bitch - the same as the cow's
- f) Functions of the reproductive parts of the doe - the same as the cow's
- g) Functions of the reproductive parts of the fowl
    - 1) Ovary - produces ova, with the nucleus of an egg attached to a yolk sac
    - 2) Oviduct - transports the mature yolk to the cloaca; carries semen
    - 3) Infundibulum - the site of fertilization; it receives the mature yolk from the ovary and stores semen in its folds
    - 4) Magnum - secretes the albumen that surrounds the yolk
    - 5) Isthmus - adds the shell membranes to the egg yolk and white
    - 6) Uterus - adds a thin white, shell, and pigment
    - 7) Vagina - produces the cuticle, or exterior egg coat, and stores the egg before laying
    - 8) Cloaca - the junction of the digestive and reproductive systems; receives the male's semen and passes the egg during laying
    - 9) Vent - opening through which the egg is laid

3. Ask students why hormones are important in the female reproductive system. Discuss the female hormones.

What are the female reproductive hormones?

- a) Mammals
    - 1) Gonadotrophin releasing hormone (GnRH)
    - 2) Follicle stimulating hormone (FSH)
    - 3) Luteinizing hormone (LH)

        4) Estrogen
        5) Progesterone
        6) Prostaglandin
    b) Fowl
        1) FSH
        2) LH
        3) Estrogen
        4) Progesterone

4. Discuss the role of hormones in successful reproduction. Use TM 2.9 to show how the hormones function in the female reproductive system.

    What role does each of the female hormones play in reproduction?

    a) GnRH - stimulates the release of FSH and LH
    b) FSH - stimulates the development of a mature ovum
    c) Estrogen - causes the development of sex organs and secondary sex characteristics and a desire to mate; also suppresses further FSH secretion from the pituitary and encourages the production of LH; assists in sperm transport by causing uterine contractions
    d) LH - causes the follicle to release the ovum and develops the corpus luteum
    e) Progesterone - prevents FSH and LH production, as well as follicle development and the secretion of estrogen; maintains a pregnancy by preventing uterine contractions and triggering secretions to nourish the egg and blocks further ovarian activity by inhibiting the secretion of GnRH
    f) Prostaglandin - ends progesterone production by causing the deterioration of the corpus luteum
    g) Hormones in fowl
        1) FSH - stimulates the reproductive system, developing the yolks and causing the secretion of estrogen and progesterone
        2) Estrogen - increases blood calcium, protein, fats, vitamins, and other egg formation substances and separates the pubic bones and enlarges the vent for egg laying
        3) Progesterone - causes the hypothalamus to trigger LH production
        4) LH - stimulates the release of the mature yolk

F. Other Activities

Have a local veterinarian come and talk to the class about the female reproductive system and some problems that might occur that would make reproduction difficult or impossible.

G. Conclusion

The female reproductive system consists of a number of parts. Hormones also play a very important role in the development and functioning of the reproductive system. The parts and hormones interact together in a complex manner for successful reproduction.

H. Answers to Activity Sheets

AS 2.1

1. Uterus
2. Uterine horn
3. Ovary
4. Uterine body

5. Bladder
6. Infundibulum
7. Oviduct
8. Cervix
9. Vagina
10. Opening of urethra
11. Clitoris
12. Vulva

AS 2.2

1. Infundibulum
2. Ovary, infundibulum, oviduct, uterus, cervix, vagina, clitoris, and vulva
3. The sperm is deposited in the vagina and then travels through the cervix to the uterus and the oviduct.

I. Answers to Evaluation

1. Uterine body
2. Uterus
3. Infundibulum
4. Bladder
5. Vagina
6. Clitoris
7. Uterine horn
8. Ovary
9. Oviduct
10. Cervix
11. Opening of urethra
12. Vulva
13. i
14. c
15. g
16. f
17. e
18. a
19. j
20. b
21. c
22. c
23. a
24. Infundibulum, magnum, isthmus, uterus, and vagina

25. Progesterone maintains the pregnancy by preventing uterine contractions and triggering secretions to nourish the egg. It also blocks further ovarian activity by inhibiting the secretion of GnRH.

26. FSH production is stimulated by increasing light. FSH develops the yolks and causes the secretion of estrogen and progesterone.

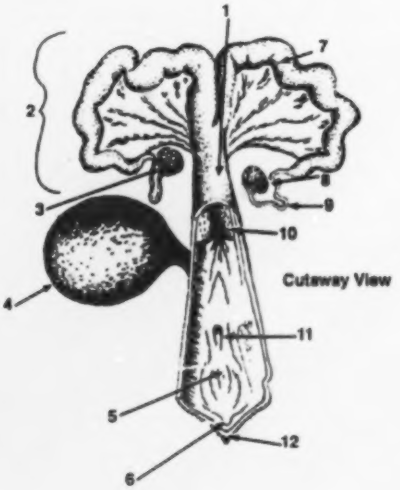
UNIT - INTRODUCTION OF ANIMAL REPRODUCTION Name________________________

Lesson 2: Female Reproductive System Date________________________

EVALUATION

In the blanks provided, label the numbered parts of the diagram of the reproductive system of a sow.

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________
11. ______________________
12. ______________________



Match the terms listed on the right for the parts of the reproductive system of a cow and a fowl with the best definition.

13. _____ Part that in a cow consists of two horns and a body
14. _____ A funnel-shaped part that received eggs from the ovary
15. _____ Site where fertilization occurs in the cow
16. _____ Organ in which eggs are generated and female sex hormones are produced
17. _____ Part that secretes the albumen that surrounds the egg in fowl
18. _____ Part located between the uterus and the vagina in the cow
19. _____ Site where semen is deposited in a cow by a bull

a. Cervix
b. Clitoris
c. Infundibulum
d. Isthmus
e. Magnum
f. Ovary
g. Oviduct
h. Uterine horn
i. Uterus
j. Vagina
k. Vulva
l. Cloaca

Circle the letter that corresponds to the best answer.

20. Which hormone stimulates the development and function of the follicle?

    a. Estrogen
    b. FSH
    c. LH
    d. Progesterone

21. Which hormone develops the corpus luteum, the yellow body?

    a. Estrogen
    b. FSH
    c. LH
    d. Progesterone

22. Which hormone prevents FSH and LH production?

    a. Estrogen
    b. GnRH
    c. Progesterone
    d. Prostaglandin

23. Which hormone develops the other sex organs?

    a. Estrogen
    b. FSH
    c. LH
    d. Progesterone

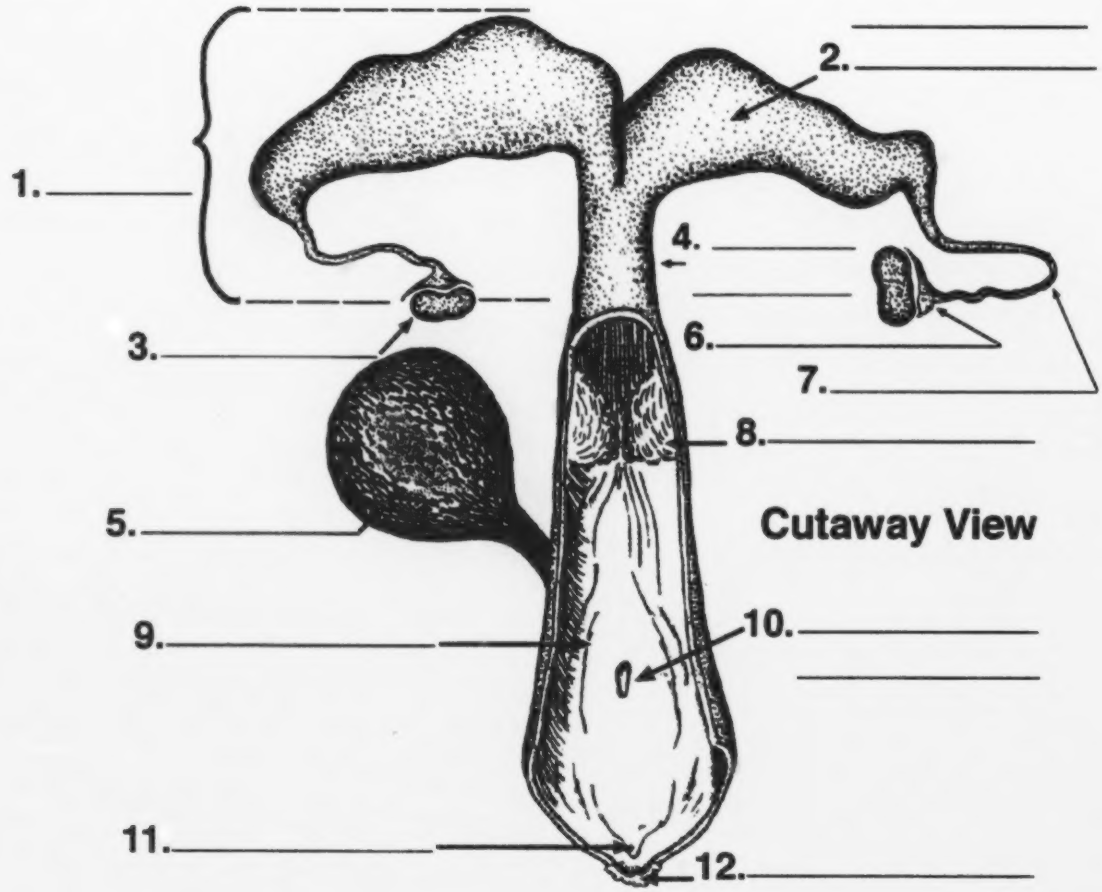
Complete the following short answer questions.

24. What are the five parts of the chicken's oviduct?

25. What is the role of progesterone in the sow after the egg is fertilized?

26. In fowl, what triggers the secretion of FSH, and what is its role in reproduction?

Reproductive System of the Cow - Top View


1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________
Cutaway View
9. ____________
10. ____________
11. ____________
12. ____________

TM 2.2

Reproductive System of the Cow - Top View (Overlay)

Uterine
Horn

Uterus

Uterine
Body

Infundibulum

Ovary

Oviduct

Cervix

Bladder

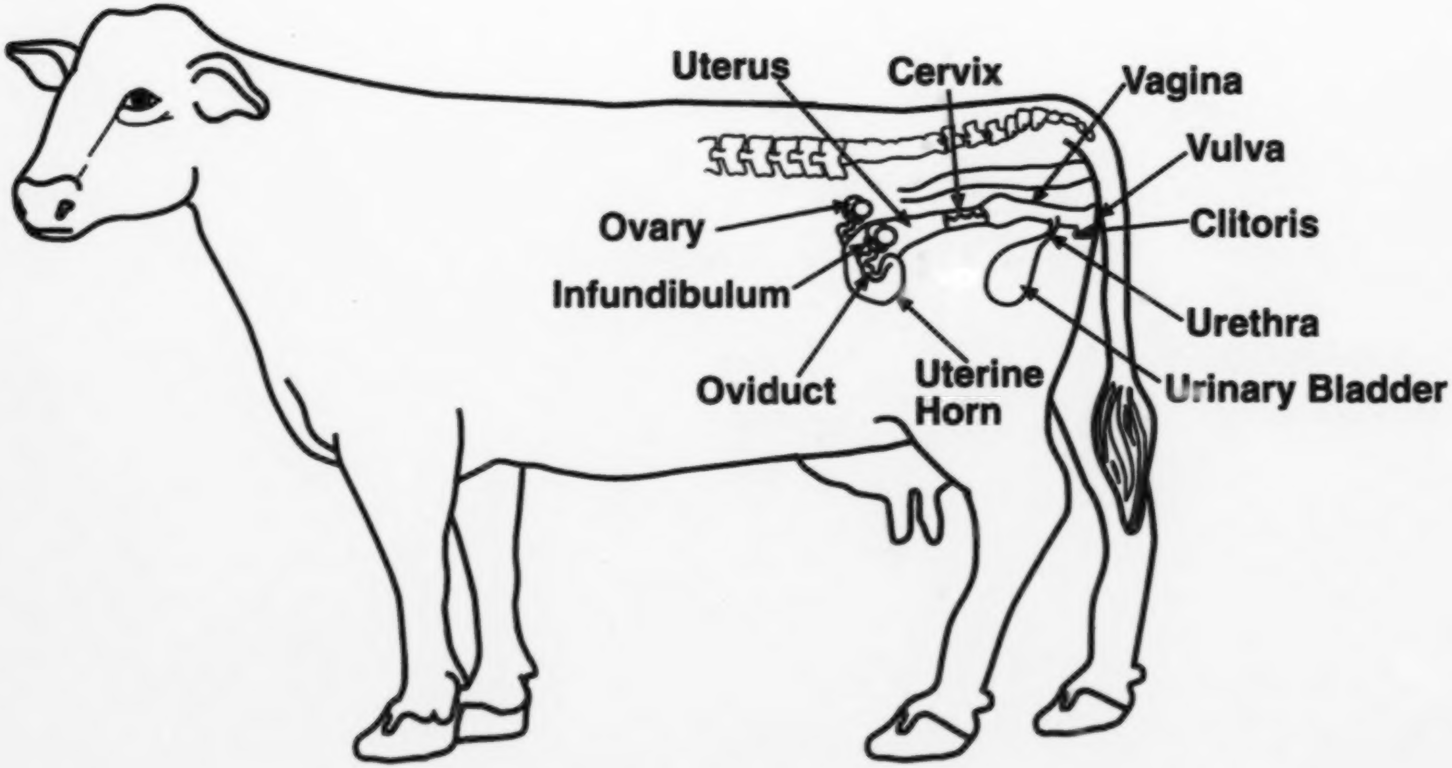
Opening of
Urethra

Vagina

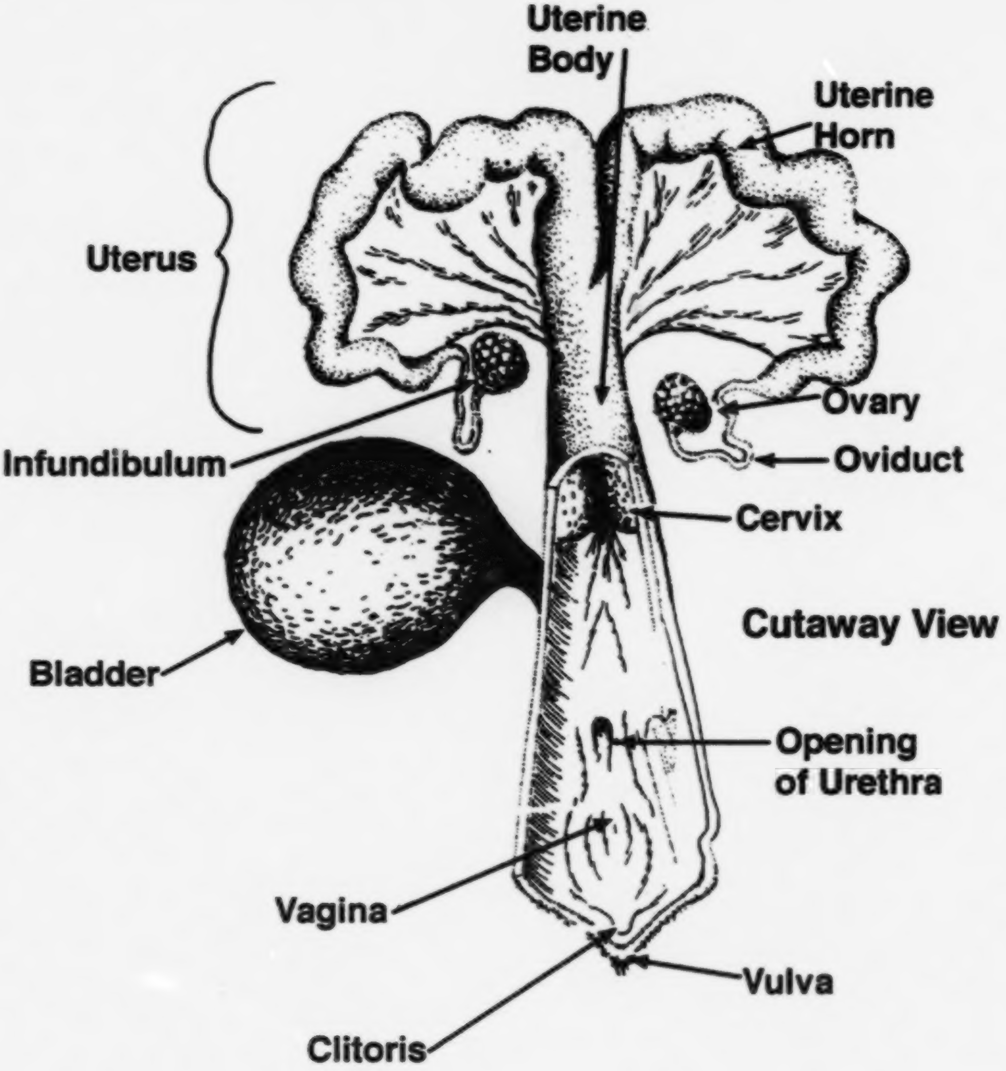
Clitoris

Vulva

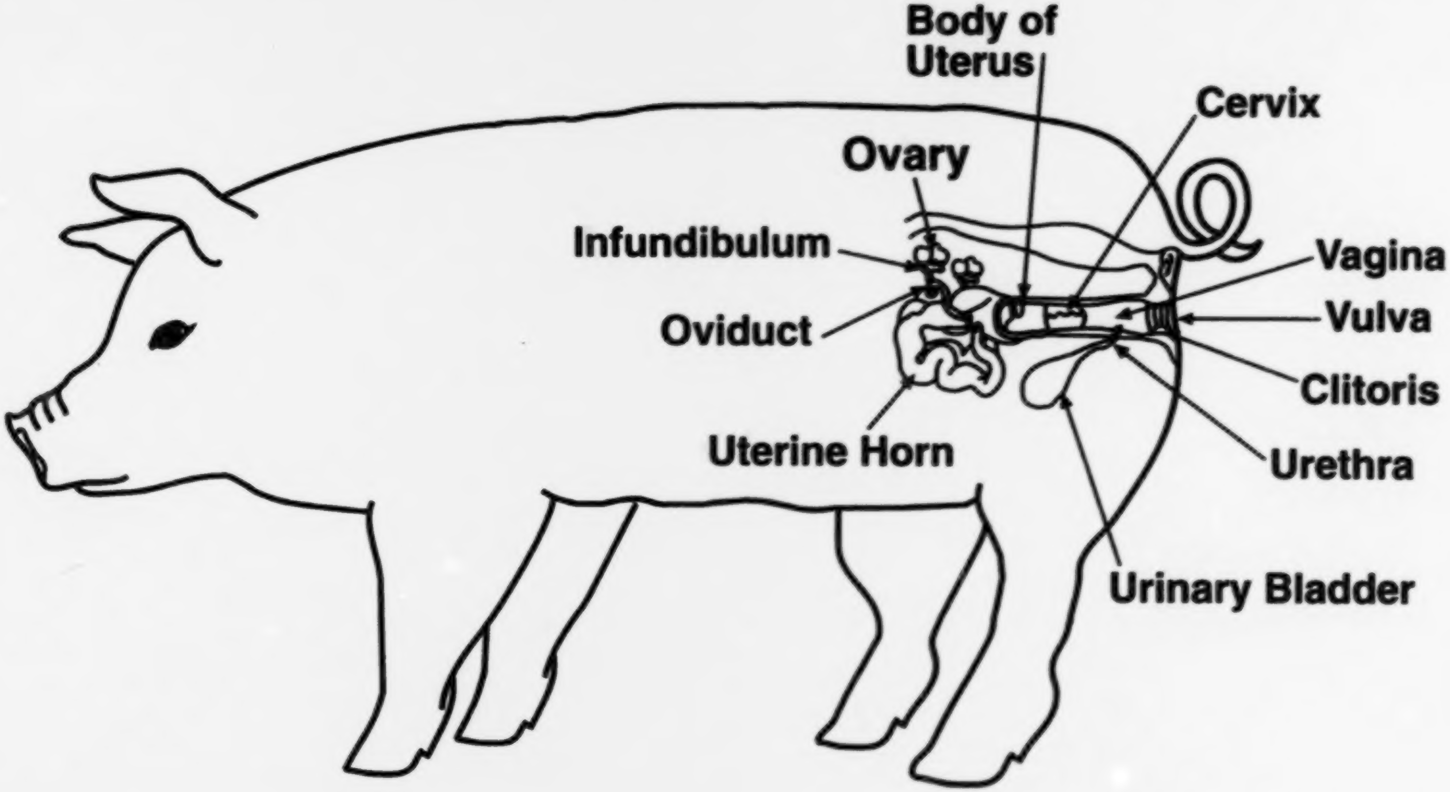
Reproductive System of the Cow - Side View


Uterus
Cervix
Vagina
Vulva
Ovary
Clitoris
Infundibulum
Urethra
Oviduct
Uterine Horn
Urinary Bladder

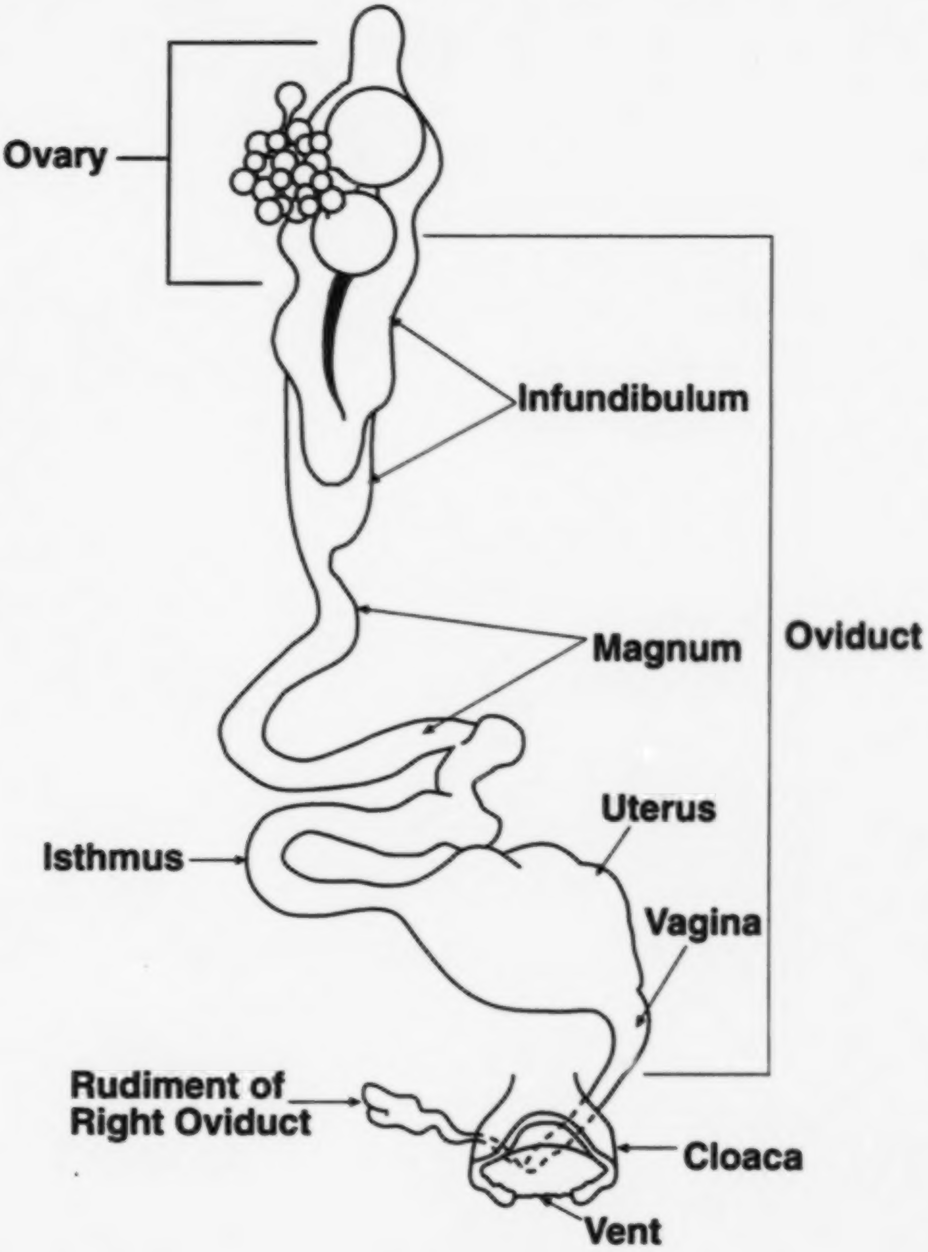
Reproductive System of the Sow - Top View


Uterine Body
Uterine Horn
Uterus
Ovary
Oviduct
Infundibulum
Cervix
Cutaway View
Bladder
Opening of Urethra
Vagina
Vulva
Clitoris

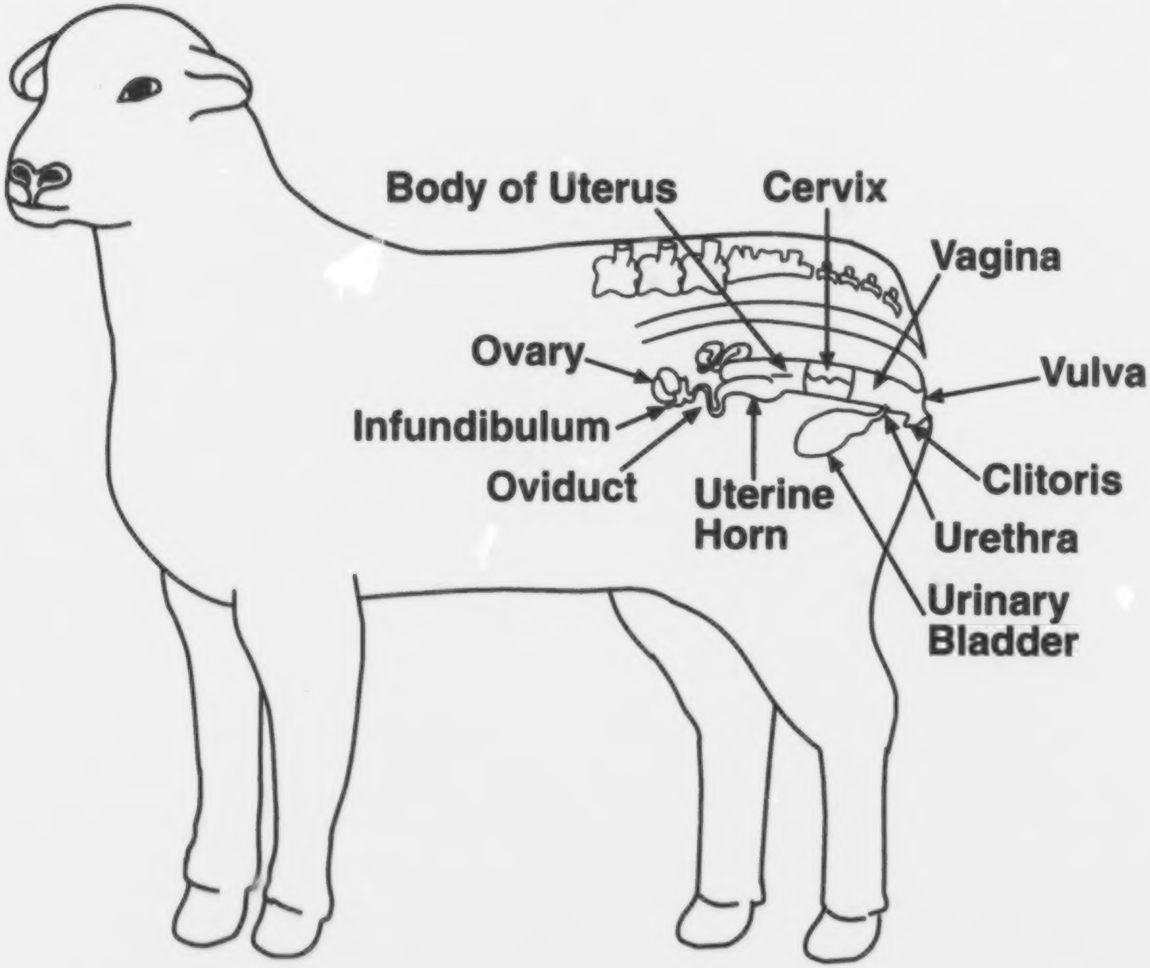
Reproductive System of the Sow - Side View


Body of Uterus
Cervix
Ovary
Infundibulum
Vagina
Vulva
Oviduct
Clitoris
Uterine Horn
Urethra
Urinary Bladder

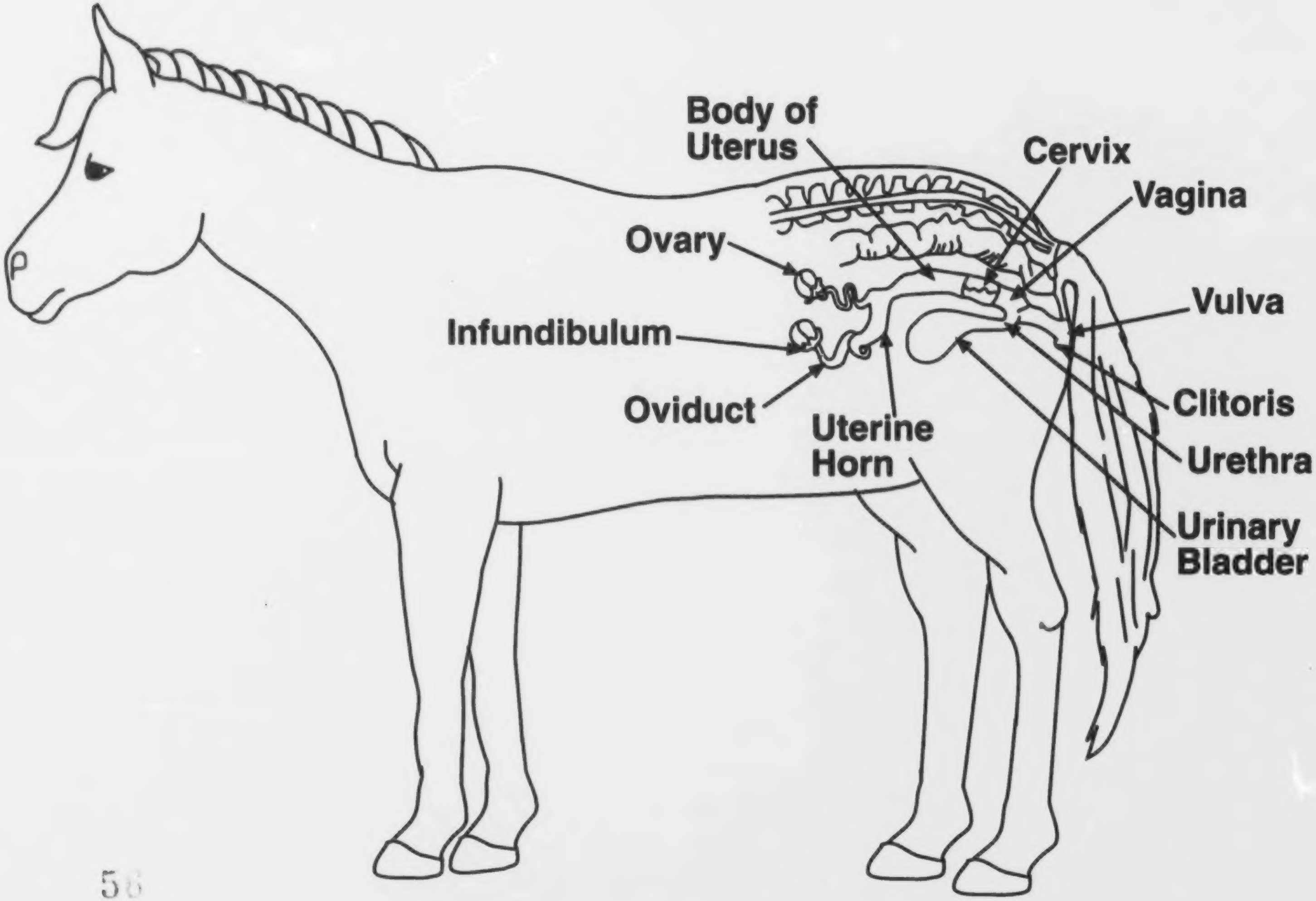
Reproductive System of Fowl - Hen


Ovary
Infundibulum
Magnum
Oviduct
Uterus
Isthmus
Vagina
Rudiment of Right Oviduct
Cloaca
Vent

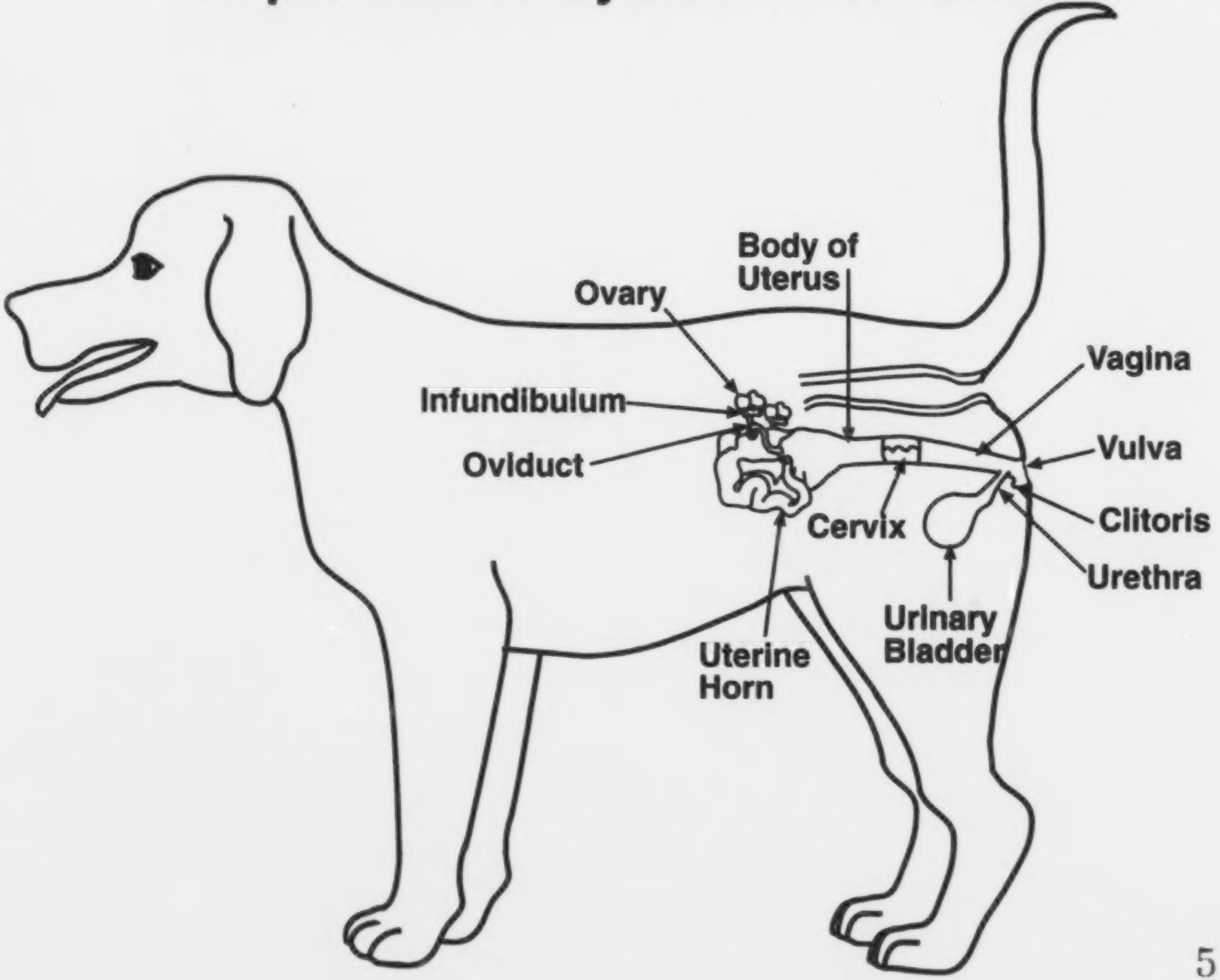
Reproductive System of the Ewe


Body of Uterus
Cervix
Vagina
Ovary
Vulva
Infundibulum
Oviduct
Uterine Horn
Clitoris
Urethra
Urinary Bladder

Reproductive System of the Mare

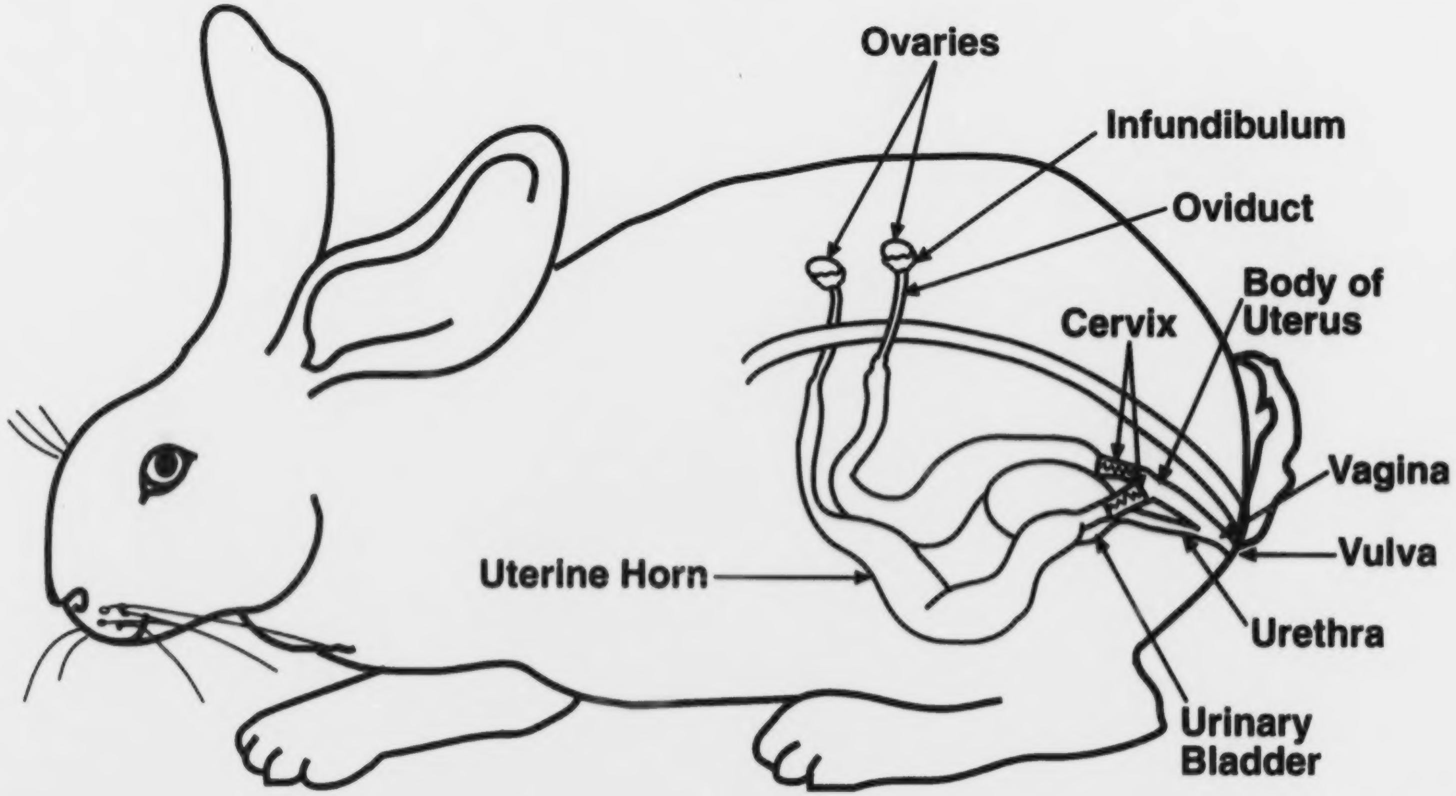

Body of Uterus
Cervix
Vagina
Ovary
Vulva
Infundibulum
Oviduct
Uterine Horn
Clitoris
Urethra
Urinary Bladder

Reproductive System of the Bitch



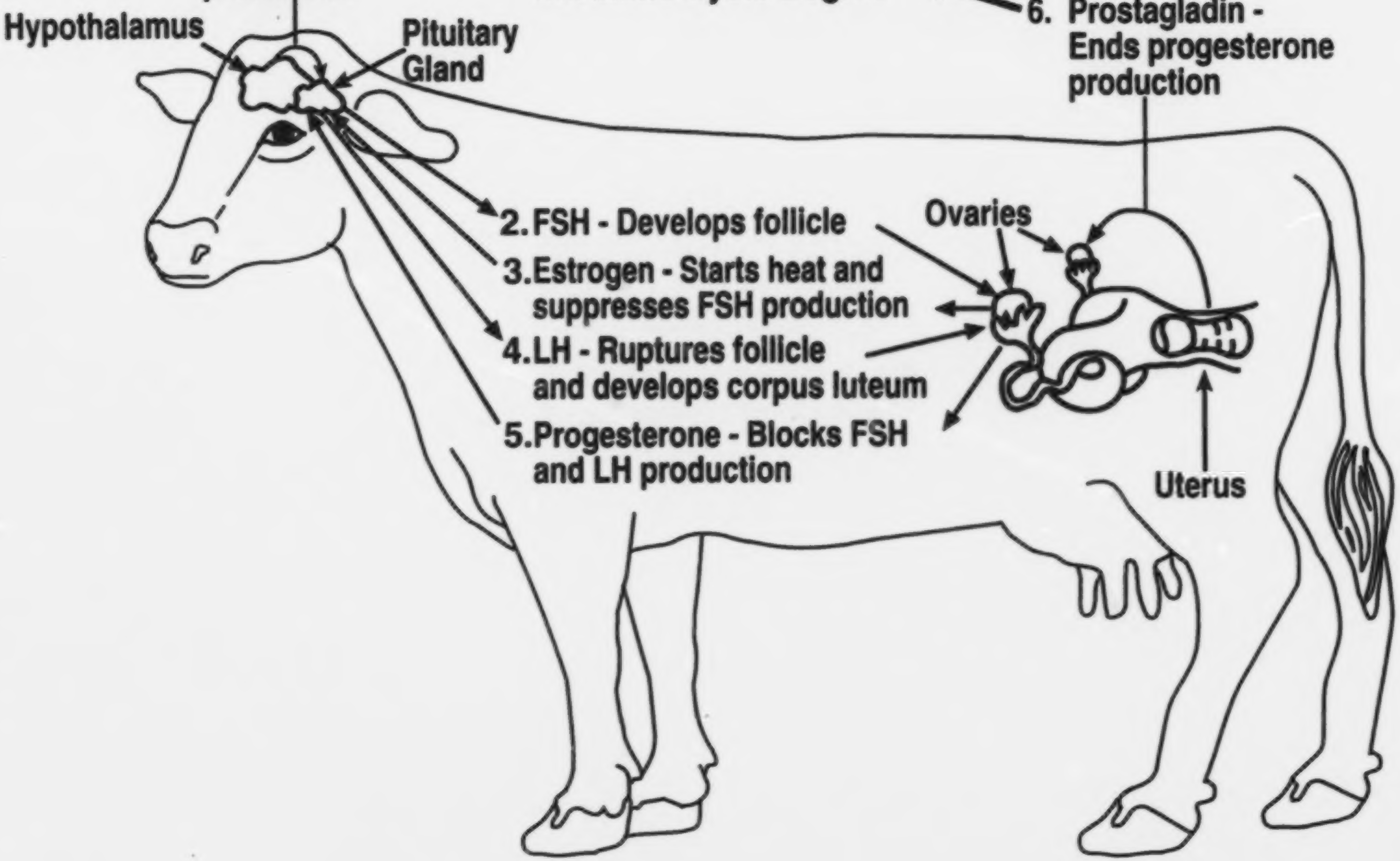
Body of Uterus
Ovary
Infundibulum
Oviduct
Vagina
Vulva
Clitoris
Cervix
Urethra
Urinary Bladder
Uterine Horn

Reproductive System of the Doe


Ovaries
Infundibulum
Oviduct
Body of Uterus
Cervix
Vagina
Vulva
Uterine Horn
Urethra
Urinary Bladder

TM 2.10

Hormone Cycle


Hypothalamus
Pituitary Gland
Ovaries
Uterus

1. GnRH - Triggers FSH and LH production

Hormone Cycle Begins

6. Prostagladin - Ends progesterone production

2. FSH - Develops follicle

3. Estrogen - Starts heat and suppresses FSH production

4. LH - Ruptures follicle and develops corpus luteum

5. Progesterone - Blocks FSH and LH production

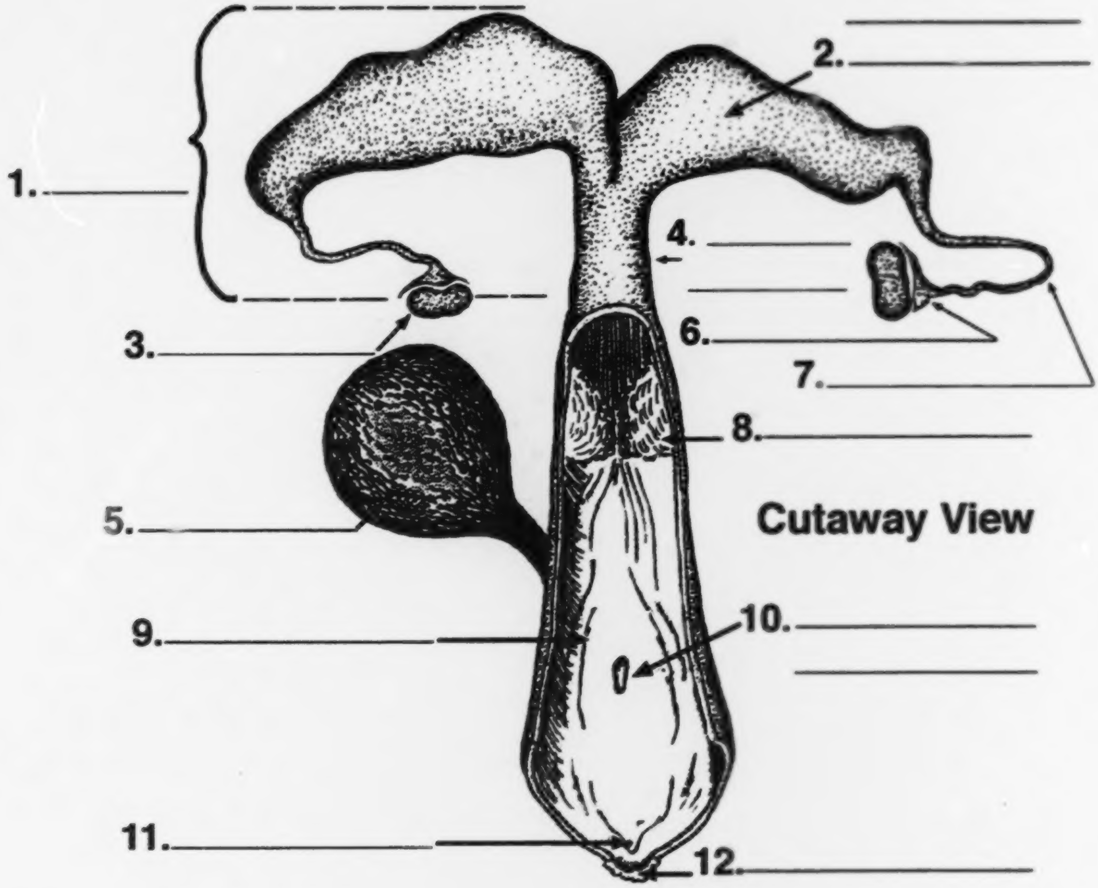
Lesson 2: Female Reproductive System

Name______________________________

Reproductive System of the Cow

Objective: Identify the parts of the reproductive system of the cow.

Label the parts of the reproductive system.


1.
2.
3.
4.
5.
6.
7.
8.
Cutaway View
9.
10.
11.
12.

64

Lesson 2: Female Reproductive System

Name________________________

Dissection of a Female Reproductive Tract

Objective: Identify the female reproductive parts in a lab dissection exercise.

Activity Length: 30 minutes

Materials and Equipment:

Female reproductive tract
Dissecting knife
Lab coat
Lab gloves (palpation sleeves may be used)

Procedure:

1. Before beginning the dissection, put on the lab coat and gloves.
2. Locate the ovaries. Using the knife, separate them from the rest of the reproductive tract.
3. Locate the oviducts and sever them from the uterine horns. Note the infundibulum.
4. Next, cut between the cervix and the uterus, separating them. Make an incision to examine the interior of the uterus and the uterine horns.
5. Find the junction of the cervix and the vagina and separate the two organs.
6. Make an incision in the top of the vagina and locate the urethra opening and the clitoris at the base of the vagina.
7. Separate the vulva from the vagina.

Key Questions:

1. What is the name of the part of the oviduct that is next to the ovary?
2. List in order the parts of the female reproductive system, starting with the ovary and ending with the external opening.
3. What is the path taken by the sperm when deposited in the female reproductive tract?

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 3: Puberty and the Estrous Cycle

Competency/Objective: Explain the role of puberty and the estrous cycle in reproduction.

Study Questions

1. **What is puberty?**
2. **At approximately what age does each species reach puberty?**
3. **What is estrus?**
4. **How do estrous cycles differ for various species?**
5. **How does estrus length differ among species?**
6. **What are the visual signs of estrus in each species?**
7. **What factors determine when an animal should be bred for the first time?**

References

1. *Introduction to Animal Reproduction (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
2. Transparency Masters
    a) TM 3.1: Puberty Age, Estrous Cycle Length, and Estrus Length
3. Activity Sheets
    a) AS 3.1: Gathering Breeding Age Information

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 3: Puberty and the Estrous Cycle

TEACHING PROCEDURES

A. Review

The two previous lessons described the parts of the male and female reproductive systems and their functions, as well as the role of hormones. This lesson will cover the sexual maturation that occurs during puberty. The estrous cycle will also be discussed.

B. Motivation

Ask students why it is important to know when to first breed an animal. Indicate that in order to benefit economically and productively through healthy offspring, the breeder must make a careful decision about when to breed for the first time based on puberty and the estrous cycle. Ask the students to define puberty and explain the role of the estrous cycle in reproduction.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students to explain puberty. Discuss puberty and its importance in reproduction. Describe what happens in the female reproductive system during puberty.

   What is puberty?

   Puberty is the stage during which the animal becomes sexually mature. In males, the animal is then able to produce viable sperm and has a desire to mate. In females, puberty involves the production of ova, the development of the reproductive tract, and a desire for mating. Puberty in the female mammal is identified by the first estrus.

2. Each species goes though puberty. Point out that animals reach puberty at different ages. Compare species using TM 3.1. Remind students that nutrition, physical size, and breed all affect the age at which a particular animal reaches puberty.

   At approximately what age does each species reach puberty?

   a) Heifer - between 6 and 12 months
   b) Gilt - between 4 and 8 months
   c) Ewe - between 5 and 9 months
   d) Mare - between 10 and 12 months
   e) Bitch - between 6 and 12 months
   f) Doe - between 5 and 8 months
   g) Fowl - chickens between 17 and 26 weeks; turkeys between 27 and 30 weeks

3. Ask students what estrus is and how it is connected to puberty. Discuss the role the estrous cycle has in reproduction and describe the relationship between the estrous cycle and estrus.

What is estrus?

a) Estrus is the period in which the female is receptive to mating. Estrus occurs at intervals; each interval is called an estrous cycle.
b) During the estrous cycle, the reproductive tract is prepared for the release of the egg and to receive the fertilized egg.
c) The estrous cycle has three phases.
    1) Proestrus - The follicle matures.
    2) Estrus - The female is receptive to mating, and the egg is released.
    3) Diestrus - The reproductive tract is less active.

4. Describe how the estrous cycle differs for various species, occurring at different times and seasons depending on the species. Use TM 3.1 to compare the different estrous cycles.

How do estrous cycles differ for various species?

a) Monoestrus species have estrus only once in a breeding season or year (e.g. dogs).
b) Some species are polyestrus, with more than one estrus per breeding season or year. Sheep and horses are different from other polyestrus species in that they are seasonal breeders. In most breeds of sheep, the ewe has estrous cycles only during the fall. The period in which the ewe is not cycling is called anestrus. The mare usually experiences anestrus in the winter and cycles from around March until October or November. The variations in the estrous cycles of sheep and horses are triggered by changes in the length of days during the year.
c) Estrous cycles also differ in length for different species.
    1) Cow - from 17 to 24 days, with an average of 21 days
    2) Sow - between 18 and 24 days, with an average of 21 days
    3) Mare - an average of 21 days, with a range of 18 to 25 days
    4) Ewe - an average of 16 days, with a range of 14 to 20 days
    5) Doe - an average of 15 days, with a range of 15 to 16 days
    6) Bitch - does not have an estrous cycle, but is in anestrus until it experiences proestrus, estrus, and diestrus once each breeding season

5. Point out that estrus is a window of opportunity for mating, and consequently breeding, to occur. Stress that estrus length is an important consideration for breeding, since estrus is the only time when the female is receptive to mating. Refer to TM 3.1 for comparisons.

How does estrus length differ among species?

a) Cow - an average length of 18 hours, with a 10 to 30 hour range
b) Sow - an average of 3 days, with a range of 1 to 5 days
c) Ewe - an average of 30 hours and a range of 22 to 38 hours
d) Mare - an average of 5 days, with a range of 1 to 10 days
e) Bitch - an average of 9 days, with a 5 to 19 day range
f) Doe - does not have a well-defined estrus period, since ovulation is stimulated by mating

6. Discuss how an individual can determine whether an animal is in heat. Ask the students to list some common visual signs of estrus. Discuss the signs found in each species.

What are the visual signs of estrus in each species?

a) Cow
    1) Mounting other females or allowing itself to be mounted
    2) Agitation or nervousness

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        - 3) Frequent urination
        - 4) Swollen vulva
        - 5) Vaginal discharges
    - b) Sow - same signs as the cow
        - 1) Occasional loud grunting
        - 2) Immobile stance with ears held erect
    - c) Ewe
        - 1) Slightly swollen vulva
        - 2) Vaginal mucus discharge
        - 3) Seeking the ram and standing to be mounted
    - d) Mare
        - 1) Raised tail
        - 2) Relaxed vulva
        - 3) Mucus discharges
        - 4) Disturbing other mares
        - 5) Nervousness
        - 6) Nickering
        - 7) Frequent urination
        - 8) Winking of vulva
    - e) Bitch
        - 1) Behavioral changes, such as an increase or decrease in appetite
        - 2) Swollen vulva
        - 3) Cessation of a bloody discharge begun during proestrus
        - 4) Acceptance of the male for mating
    - f) Doe
        - 1) Reddish-purple, slightly swollen vulva
        - 2) Acceptance of the male for mating

7. Ask students when a heifer should be bred the first time. Indicate that many factors play a role in determining the correct breeding time and that what might be the appropriate time for breeding for one heifer may not be the right time for another. Describe the factors to look for in deciding when to breed an animal.

    What factors determine when an animal should be bred for the first time?

    - a) Should not be bred at puberty; may not be physically equipped for successful reproduction
    - b) Factors influencing the first breeding
        - 1) Physical size - weight and size of frame
        - 2) Age - past puberty and fully sexually mature
        - 3) Breed - variation of maturation time by breed

F. Other Activities

Using the information in the lesson, have students make an estrous cycle time line for each species. The time line should indicate the time at which puberty is expected to occur, as well as the average interval at which the estrous cycle repeats.

G. Conclusion

Puberty occurs in animals as they become sexually mature, which happens at different ages in different animals. The first estrus, which can be identified by certain visual signs, is an indication of puberty in the female. The length of estrus and the estrous cycle vary among species. After puberty occurs, physical size, age, and breed are factors to consider when determining when an animal should be bred for the first time.

H. Answers to Activity Sheets

Answers will depend on the responses from the sources.

I. Answers to Evaluation

1. d
2. b
3. b
4. b
5. b
6. c
7. c
8. a

9. The five visual signs of estrus in the cow are mounting, agitation or nervousness, frequent urination, swollen vulva, and vaginal discharges from vulva.

10. Age, physical size, and breed will determine when to first breed an animal.

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UNIT - INTRODUCTION TO ANIMAL REPRODUCTION Name ____________________

Lesson 3: Puberty and the Estrous Cycle Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is the name of the stage in which the reproductive tract develops?

   a. Estrus
   b. Diestrus
   c. Proestrus
   d. Puberty

2. A horse reaches puberty at ______________ months.

   a. 8
   b. 12
   c. 18
   d. 24

3. What is the name of the stage in which the female is receptive to mating?

   a. Diestrus
   b. Estrus
   c. Metestrus
   d. Proestrus

4. Which of the following does not have an estrous cycle?

   a. Cattle
   b. Fowl
   c. Sheep
   d. Swine

5. Which species is monoestrus?

   a. Cattle
   b. Dogs
   c. Horses
   d. Sheep

6. What species has an average estrous cycle of 16 days?

   a. Cattle
   b. Horses
   c. Sheep
   d. Swine

7. A sow has an average estrus length of ____________________.

a. 18 hours
b. 30 hours
c. 3 days
d. 5 days

8. In which species is ovulation triggered by the act of mating?

a. Rabbits
b. Swine
c. Dogs
d. Horses

Complete the following short answer questions.

9. What are the five visual signs of estrus in the cow?

a.

b.

c.

d.

e.

10. What are the factors examined when deciding when a female should be bred for the first time?

Puberty Age, Estrous Cycle Length, and Estrus Length

Species	Puberty	Estrous Cycle	Estrus
Cattle	6-12 months	21 days (17-24 days)	18 hours (10-30 hours)
Swine	4-8 months	21 days (18-24 days)	3 days (1-5 days)
Sheep	5-9 months	16 days (14-20 days)	30 hours (22-38 hours)
Fowl	17-30 weeks (depends on type)	-------	-------
Horses	10-12 months	21 days (18-25 days)	5 days (1-10 days)
Dogs	6-12 months	-------	9 days (5-19 days)
Rabbits	5-8 months	15 days (15-16 days)	not well defined

Lesson 3: Puberty and the Estrous Cycle

Name______________________________

Gathering Breeding Age Information

Objective: Gather breeding information from local sources.

Activity Length: Length depends on responses from sources.

Materials and Equipment:

Sources of information for different breeds--veterinarians, feed companies, extension livestock specialists
Computer for letter writing

Procedure:

1. Select a source to contact for the information on when to breed different species and breeds for the first time. Choose three different breeds of one species of animal to research.
2. Prepare a letter requesting information regarding the age and weight at which each of the three species should first be bred. Mail the letter to the selected source.
3. After receiving information from the source, fill out the table, listing the species and breed and the age and weight at the first breeding. Include all of the information gathered by the class.

Key Questions:

1. What is the minimum age and weight a heifer can be bred? What breed is the heifer?
2. Which breed of swine is the oldest when first bred? What age should it be?
3. Which species can be bred at the youngest age?

Species	Breed	Age at First Breeding	Weight at First Breeding

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 4: Conception and Gestation

Competency/Objective: Describe conception and gestation.

Study Questions

1. **What is conception and where does it occur?**
2. **What methods are used to impregnate?**
3. **What procedures can be used to determine pregnancy?**
4. **What is gestation and its three stages?**
5. **What are the embryonic membranes and their functions?**
6. **What factors influence the length of gestation?**
7. **What is incubation?**
8. **How do gestation and incubation lengths differ between species?**

References

1. *Introduction to Animal Reproduction (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
2. Transparency Masters
    a) TM 4.1: Embryonic Membranes of a Pig
    b) TM 4.2: Gestation and Incubation Lengths for Different Species
3. Activity Sheets
    a) AS 4.1: Gestation and the Reproductive Tract

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 4: Conception and Gestation

TEACHING PROCEDURES

A. Review

The previous lesson covered puberty and the estrous cycle. After puberty, the conception of new life can take place when mating occurs. Conception marks the beginning of the development of the fetus during gestation. This lesson will describe conception and gestation.

B. Motivation

1. Place one balloon inside another. Fill the inner balloon with water and tie it shut. Then fill the outer balloon with water. The balloons can be used to simulate the function of the placenta during gestation. Have students attempt to break the inner balloon to demonstrate how the fetus is protected during its development.

2. Ask students how they think an embryo develops in preparation for birth. Describe how gestation prepares the fetus to survive outside the mother's body. If possible, show pictures of an embryo and fetus during gestation.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students what happens during conception.

What is conception and where does it occur?

a) Conception occurs when a single sperm unites with the egg, creating an embryo.
b) Conception occurs in the oviduct, usually in the upper third.
c) In swine, dogs, and rabbits, multiple ova are released and fertilized.
d) In fowl, the egg and sperm unite in the infundibulum. Fertilization takes place at the germinal disk on the yolk, which contains the nucleus.

2. In nature, for females to become pregnant, mating has to occur. However, other ways to impregnate a female do exist. Discuss with the students the different ways in which a female may be impregnated. To illustrate the hormone cycle, refer back to TM 2.11.

What methods are used to impregnate?

a) Natural breeding - male copulates with the female
b) Artificial insemination
    1) Semen is collected from the male and stored.
    2) During estrus, the previously collected semen is inserted into the female reproductive tract.
c) Embryo transfer
    1) The female releases many eggs during ovulation because of FSH injections.
    2) The eggs are fertilized either by natural or artificial mating.

    3) After conception, the embryos are collected from the female and transferred to other females for the pregnancy.
    4) ET cannot be used in fowl.

3. Discuss the economic and biological importance of being able to determine pregnancy. Describe the different procedures used to determine pregnancy. Hand out AS 4.1 and complete the activity.

What procedures can be used to determine pregnancy?

a) Visual inspection
    1) No visual signs of estrus are present.
    2) The abdomen is enlarged late in pregnancy.
b) Rectal palpation
    1) Rectal palpation involves inserting an arm into the rectum and feeling for the distended uterus or for cotyledons.
    2) A modified version is used in sheep in which a rod is inserted in the rectum to move the fetus so it can be felt.
c) Abdominal palpation - The abdomen is externally examined by hand. During pregnancy, the uterus becomes enlarged and can be felt.
d) Ultrasonic sound
    1) Used for many species, pregnancy checking by ultrasonic sound involves using a transducer attached to a machine and a sealant.
    2) With a sealant being used to exclude air from between the transducer and the body, the transducer transmits ultrasonic sound waves through the body.
    3) The sound waves are reflected by tissue. When the waves encounter a fetus, the unit will light up or sound to indicate pregnancy.
e) In a laboratory situation, pregnancy may be determined through blood tests or even x-rays.

4. Ask students what gestation is. Discuss when gestation begins. Identify the three stages of gestation. Discuss the importance of gestation.

What is gestation and its three stages?

a) Gestation is the period of development for offspring beginning at conception and ending at birth. During gestation, the fetus receives nutrients and oxygen from the mother through the placenta and gives off carbon dioxide and waste products that are absorbed by the mother.
b) The fetus goes through three stages of gestation.
    1) Cell division stage - The embryo undergoes 16 or more cell divisions as it is transported to the uterus.
    2) Embryonic stage - Body parts are differentiated, and important organs are formed. When the embryonic stage is complete, a fetus has developed.
    3) Fetal period - The fetus grows until birth.

5. Discuss why the embryo needs protection and nutrients. Using TM 4.1, discuss the roles of each of the embryonic membranes in providing protection and nutrients.

What are the embryonic membranes and their functions?

a) Chorion - The chorion is connected to the uterus. The points of attachment provide nourishment and waste disposal for the embryo.

b) Amnion - The amnion is a sac that surrounds the embryo itself and contains amniotic fluid to protect the embryo from shock. The umbilical cord connects the amnion to the embryo's navel. The cord also provides nourishment to the embryo.
c) Allantois - The allantois, which is an extension of the urinary system of the embryo, lies between the amnion and the chorion. It contains allantoic fluid, which originates in the embryo's kidney.

6. The length of gestation differs for each mother within a species. Ask students what would cause these differences in gestation lengths. Discuss the influence of these factors on gestation length.

What factors influence the length of gestation?

a) Breed of the mother
b) Mother's age
c) Individual variation - Two mothers may be the same age and breed but may still have different gestation lengths.
d) Weather
e) Choice of sire

7. Discuss how the development of the embryo in fowl differs from the gestational process described above.

What is incubation?

a) The time from when the hen sits on an egg or it is placed in an incubator to its hatching is called incubation. Incubation is a period of fetal development analogous to gestation.
b) The embryo is nourished by the yolk.
c) The membranes that surround the embryo are the same as those found in mammals, although the chorion and the allantois merge to form the chorioallantoic membrane, which functions as a respiratory organ.

8. Discuss the differences among species in gestation lengths. Use TM 4.2 to illustrate the different lengths.

How do gestation and incubation lengths differ between species?

a) Cow - 281 day average gestation length with a range of 274 to 290 days
b) Sow - 114 day average gestation length with a range of 112 to 116 days
c) Ewe - 147 day average gestation length with a range of 144 and 151 days
d) Mare - 336 day average gestation length with a range of 330 to 350 days
e) Bitch - 63 day average gestation length with a range of 56 to 70 days
f) Doe - 31 day average gestation length with a range of 30 to 32 days
g) Fowl - vary in incubation length for each species, with chickens averaging 21 days and turkeys averaging 28 days

F. Other Activities

1. Have an artificial inseminator speak to the class about the procedure. The AI method should be demonstrated, either on a model or a real animal. Students may practice the procedure on a model.

2. Have a veterinarian demonstrate how to use ultrasonic sound to pregnancy check a sow. If a nearby veterinarian has a real-time ultrasound machine, take students on a field trip to observe its use.

3. Have the students contact a local feed dealer, Extension office, AI technician, or veterinarian to obtain a breeding calendar.

G. Conclusion

Conception, which takes place in the upper third of the oviduct and in the infundibulum in fowl, marks the beginning of a new life and the start of gestation in mammals and incubation in fowl. Conception may occur due to natural or artificial breeding, and several procedures can be used to determine whether pregnancy has resulted. Gestation has three stages, with gestation lengths varying due to factors such as the breed and age of the mother. During gestation and incubation, embryonic membranes are essential to the survival of the new life.

H. Answers to Activity Sheets

1. The cotyledons are the points of attachment between the placenta and the uterus.

2. Answers will vary depending on the reproductive tracts used.

3. Answers will vary depending on the reproductive tracts used.

I. Answers to Evaluation

1. b
2. c
3. c
4. b
5. c
6. a
7. b

8. Conception occurs when a single sperm unites with the egg. The union of the egg and sperm creates a new life called an embryo.

9. Natural breeding involves the cow and bull mating with the bull depositing semen in the vagina. There are two artificial methods used to impregnate a cow, artificial insemination (AI) and embryo transfer (ET). In AI, the semen is collected from the bull. When estrus is detected in the female, the collected semen is artificially inserted into the cow's reproductive tract. In ET, the female releases many eggs during ovulation because of FSH injections. The eggs are fertilized naturally or artificially. Once the eggs are fertilized, the embryos are collected from the cow and transferred to other cows for the pregnancy.

10. Gestation length may be influenced by the mother's age and breed and by individual differences between animals. The weather and the sire may also affect the length of gestation.

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION Name______________________________

Lesson 4: Conception and Gestation Date______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Where does conception occur in a sow?

   a. Ovary
   b. Oviduct
   c. Uterus
   d. Vagina

2. In which pregnancy determination method is an arm inserted into the rectum of a cow?

   a. Abdominal palpation
   b. Laboratory methods
   c. Rectal palpation
   d. Ultrasonic sound

3. The time between when the hen sits on an egg and its hatching is called ____________________.

   a. Conception
   b. Gestation
   c. Incubation
   d. Parturition

4. During what period does the fetus receive nutrients and oxygen from the mother?

   a. Conception
   b. Gestation
   c. Incubation
   d. Parturition

5. Which stage is referred to as the time of growth?

   a. Cell division
   b. Embryonic
   c. Fetal
   d. Organ development

6. A sow has an average gestation length of ________ days.

   a. 114
   b. 147
   c. 281
   d. 336

7. Which part of the embryonic membrane system protects the fetus from shock?

   a. Allantois
   b. Amniotic fluid
   c. Chorion
   d. Umbilical cord

Complete the following short answer questions.

8. What is conception?

9. What natural and artificial methods may be used to impregnate a cow? Describe each of the methods.

10. What five factors may influence gestation length?

    a.

    b.

    c.

    d.

    e.

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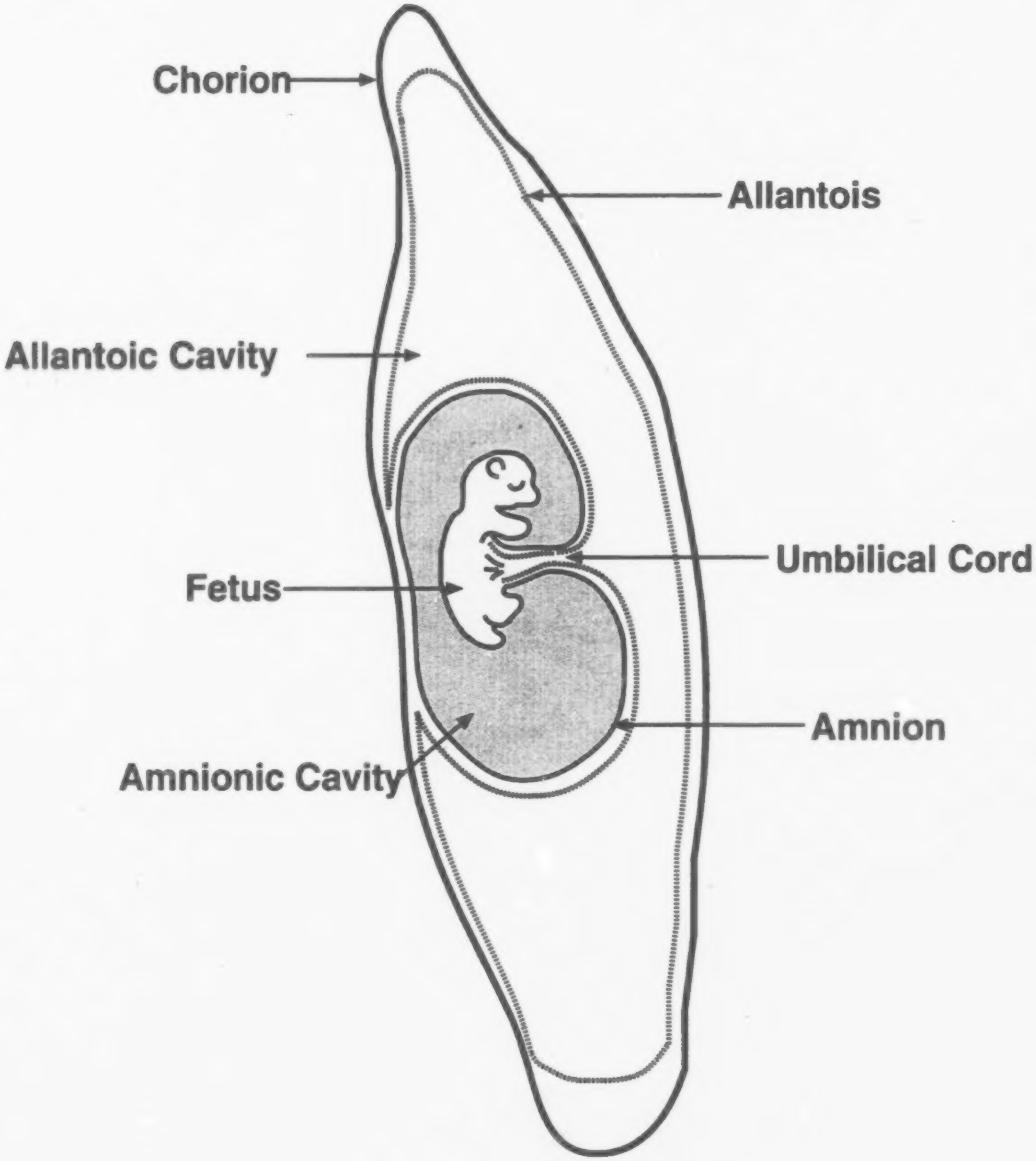
Embryonic Membranes of a Pig


Chorion
Allantois
Allantoic Cavity
Umbilical Cord
Fetus
Amnion
Amnionic Cavity

Gestation and Incubation Lengths for Different Species

Species	Gestation Length	
	Average (days)	Range (days)
Cattle	281	274-290
Swine	114	112-116
Sheep	147	144-151
Fowl (Incubation)	Chicken - 21	-------
	Turkey - 28	-------
Horses	336	330-350
Dogs	63	56-70
Rabbits	31	30-32

Lesson 4: Conception and Gestation Name ____________________

Gestation and the Reproductive Tract

Objective: Compare sow reproductive tracts at various stages of gestation.

Activity Length: 30 minutes

Materials and Equipment:

Four sow reproductive tracts
Long surgical gloves (shoulder length) or palpation sleeves
Knife

Procedure:

1. Put on the gloves.
2. Working in four groups (one for each tract), locate the uterus. Each student should feel for a fetus or cotyledons.
3. Cut open the uterus to examine the size of the fetuses, if present.
4. Examine the dissected reproductive tracts of the other groups.

Key Questions:

1. What are the cotyledons?

2. In which reproductive tract did the fetuses appear to have the longest gestation period?

3. How many fetuses were present in each tract?

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 5: Parturition

Competency/Objective: Identify the important factors of parturition.

Study Questions

1. **What is parturition?**
2. **What are the physical signs of parturition?**
3. **What role do hormones play in parturition?**
4. **What problems may occur during parturition?**
5. **What are the various malpresentations?**
6. **What are the postpartum management factors for each species?**
7. **How does the birth process for fowl differ from the other species?**

References

1. *Introduction to Animal Reproduction (Student Reference).* University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
2. Transparency Masters
    a) TM 5.1: Parturition Presentations of a Calf
3. Activity Sheets
    a) AS 5.1: Handling Parturition Difficulties

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 5: Parturition

TEACHING PROCEDURES

A. Review

The previous lesson described the beginning of a new life at conception and the period of its development during gestation. The gestational period ends in parturition, or birth. This lesson will cover parturition and its factors.

B. Motivation

Ask some of the students who have seen a birth to describe what happens. If possible, include a description of a problem birth, comparing it to a normal birth. Explain what happens in the female reproductive tract during birth, relating the information to their examples.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students what parturition is. Discuss what occurs within the reproductive tract during parturition.

   What is parturition?

   a) Parturition is the act of giving birth; it involves hormones and mechanical factors.
   b) Contractions occur to move the fetus out of the body. Labor involves the dilation of the cervix and the passage of the fetus and the placenta through the birth canal and out of the body through the vulva.

2. Ask what some of the physical signs of parturition are. Describe the signs of parturition.

   What are the physical signs of parturition?

   a) Cow
      1) Swollen udder
      2) Sunken appearance to hips or head of tail
      3) Enlarged or dropped abdominal area
      4) Reddened and swollen vulva
      5) Separation from the herd
      6) Swollen and leaking teats
      7) Increased mucus discharge
      8) Nervousness
      9) Restless switching back and forth from a standing to a resting position
      10) Appearance of water bag from the vulva
   b) Sow
      1) Enlarged abdominal area
      2) Restlessness
      3) Attempts to build a nest

    4) Swollen vulva
    5) Swelling of teats
- c) Ewe
    1) Swollen teats
    2) Swollen, slackened vulva
    3) Mucus discharge from vulva
    4) Restless shifting of position from standing to lying and back
- d) Mare
    1) Swollen udder
    2) Shrunken at hips
    3) Dropped abdomen
    4) Swollen teats
    5) Waxing and leaking of teats
    6) Swollen, relaxed vulva
    7) Separation from other horses
    8) Raised tail
    9) Frequent urination
    10) Excessive sweating
    11) Restless changing of position
    12) Breaking of water bag
- e) Bitch
    1) Refuses meals
    2) Temperature slightly below normal
    3) Vomiting
    4) Mucus discharge from vulva
- f) Doe
    1) Pulling of fur to line nest
    2) Loss of appetite
    3) Nervous and excitable

3. Identify the hormones involved in parturition and the role they play during birth.

What role do hormones play in parturition?

- a) Parturition begins with decreasing progesterone levels.
- b) Estrogen, oxytocin, and relaxin levels increase.
- c) Relaxin is produced by the corpus luteum to relax the pelvic muscles, cartilage, and ligaments.
- d) Estrogen causes the birth canal to open.
- e) Oxytocin from the pituitary, combined with estrogen, causes contractions.
- f) Prolactin is secreted by the anterior pituitary before the birth to trigger milk production.

4. Ask students what problems may arise during parturition. Discuss different circumstances that may develop into problems.

What problems may occur during parturition?

- a) Large fetus
- b) Small pelvic opening
- c) Breeding selection
    1) Large male of a particular breed is bred to a small female of the same breed
    2) Male of a large breed is bred to a female of a smaller breed
- d) Young mother
- e) Torn cervix, vagina, and vulva

   f) Prolapse
   g) Abnormal fetal position or presentation
   h) Uncontrollable fetal bleeding
   i) Infection to the mother or newborn from the birthing process

5. Ask students to describe the normal presentation of a fetus. Discuss the various malpresentations. Use TM 5.1 to illustrate different presentations.

   What are the various malpresentations?

   a) Ideal presentation for cattle, sheep, horses, dogs, and rabbits - head between the front legs, which leave the birth canal first; fetal pigs - no particular orientation for the birth process
   b) Malpresentations
      1) Backward with hind legs extended
      2) Backward with legs retained
      3) One or both forefeet retained
      4) Head bent backward
      5) Upside down
      6) Backward and upside down

6. Ask students to define postpartum management. Discuss the factors involved in postpartum management for the mother and the newborn for each species.

   What are postpartum management factors for each species?

   a) Cattle
      1) Check that the calf is breathing properly.
      2) If the mother does not dry the calf by licking, dry it with a cloth.
      3) Ensure that the calf nurses. Hand feeding may be necessary.
      4) Reduce navel infections by dipping the navel in iodine.
      5) The calf should be identified with an ear tag.
      6) Make sure the cow has expelled the afterbirth
      7) Check for signs of milk fever.
   b) Swine
      1) Check the newborn's breathing.
      2) Dry the piglet with a cloth.
      3) Make sure the piglet nurses.
      4) Remove the umbilical cord.
      5) Dip the navel in iodine.
      6) Clip the needle teeth of the piglet with side cutters to protect the mother's udder.
      7) Dock the piglet's tail.
      8) Make sure the afterbirth is expelled.
      9) Notch the ears for identification.
   c) Sheep
      1) Check the lamb's respiration.
      2) Place the lamb and the mother in a clean pen.
      3) Dry the lamb.
      4) Warm the lamb. Use heat lamps or warm water if necessary.
      5) Make sure the lamb feeds.
      6) Cut the navel cord.
      7) Use iodine on the navel.
      8) Make sure the afterbirth is expelled.
      9) Check for signs of milk fever.

d) Horses
   1) Check the respiration of the foal.
   2) Make sure the foal nurses.
   3) Cut the navel cord with a clean, dull scissors if it has not broken in five minutes.
   4) Dip the navel in iodine.
   5) Make sure the afterbirth is expelled within three hours. If not, call a veterinarian.
   6) Examine the afterbirth carefully to make sure the entire placenta is expelled.
   7) Make sure that the foal has a bowel movement in the first 24 hours.

e) Dogs
   1) Check the whelp's breathing.
   2) Dry the whelp.
   3) Ensure that it nurses.
   4) Dip the navel in iodine.
   5) Make sure the afterbirth is expelled.
   6) Check the bitch for eclampsis.

f) Rabbits
   1) Check for and remove dead newborns.
   2) Remove any afterbirth.
   3) Check that the rabbits are nursing.
   4) Make sure the nest is warm, well-drained, and well ventilated.

7. Discuss the differences between the birth processes of fowl and mammals.

How does the birth process for fowl differ from the other species?

a) Hatching - Hatching is breaking out of the egg through the shell. To ensure hatchability, temperature, humidity, and air velocity around developing eggs must be monitored.

b) Proper hatching position - The chick lies on its side along the longest axis of the egg, facing the egg's large end, with its head under its right wing; variations are malpresentations.

c) Care must be provided after hatching.
   1) Provide proper temperature in the brooder after hatching.
   2) Use a brooder guard the first few days to ensure warmth.
   3) Provide adequate humidity and space.
   4) Control lighting.
   5) Check water and feed for consumption.

F. Other Activities

Have a veterinarian speak to the class about the birthing process.

G. Conclusion

Parturition is the process of giving birth; it involves both mechanical factors and special hormones. It is important to be able to recognize the physical signs of parturition, as well as problems during birth. A knowledge of proper postpartum care is also vital. Knowledge in each of these areas will help the producer ensure the survival and health of both mother and newborn.

H. Answers to Activity Sheets

1. Abnormal - Calf has forefoot retained. Pull it forward for the calf to exit the birth canal in the normal position.

2. Normal - No assistance needed.

3. Abnormal - Head is bent backward. Assist by pushing the fetus back into the uterus and positioning the head between the legs. Pull the legs forward to exit the birth canal.

4. Abnormal - Calf is backward with feet retained. Assist by straightening the hind legs to enter the birth canal. Quickly deliver the calf backward.

I. Answers to Evaluation

1. c
2. c
3. d
4. b
5. a
6. b
7. a
8. The act of giving birth

9. The answer should include four of the following: swollen udder, sunken appearance at hips or head of tail, enlarged and dropped abdominal area, reddened and swollen vulva, seeking of a spot separate from the herd, swollen and leaking teats, mucus discharge, nervousness and restless shifting, and water bag protruding from the vulva.

10. The fetus moves from the uterus through the birth canal, which includes the cervix and the vagina, and out of the body through the vulva.

11. The embryo lies on its side along the egg's longest axis. The head is tucked under the right wing and faces the large end of the egg.

12. Abnormal
13. Normal
14. Abnormal
15. Abnormal
16. Abnormal

93

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION Name____________________________

Lesson 5: Parturition Date____________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Parturition is initiated by declining levels of ________________ from the corpus luteum.

   a. Estrogen
   b. Oxytocin
   c. Progesterone
   d. Relaxin

2. Relaxin is a hormone that relaxes the ________________.

   a. Birth canal
   b. Ovary
   c. Pelvic muscles
   d. Uterus

3. Which of the following is appropriate care for fowl after hatching?

   a. Make sure the air is very dry.
   b. Keep the newly hatched birds cool.
   c. Give the birds only water for the first few days.
   d. Use a brooder guard for the first few days.

4. Which of the following may cause a problem during parturition?

   a. A large female is bred to a small male.
   b. The female has a small pelvic opening.
   c. The mother is an older animal.
   d. The fetus is small.

5. Which hormone is responsible for milk production?

   a. Prolactin
   b. Progesterone
   c. Oxytocin
   d. Estrogen

6. Which of the following is a postpartum management factor for a newborn calf?

   a. Using a brooder guard
   b. Making sure that it nurses
   c. Clipping needle teeth
   d. Docking the tail

7. Which species may experience eclampsis?

   a. Dogs
   b. Fowl
   c. Rabbits
   d. Swine

Complete the following short answer questions.

8. What is parturition?

9. What are four physical signs of parturition of a cow?

   a.

   b.

   c.

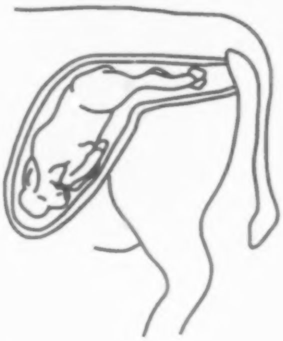
   d.

10. What is the pathway taken by the fetus during parturition?

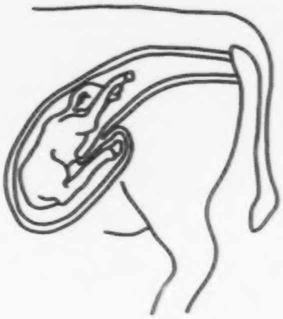
11. What is the proper hatching presentation?

Looking at the pictures, indicate on the lines provided whether the presentation is normal or abnormal.

12. __________



13. __________



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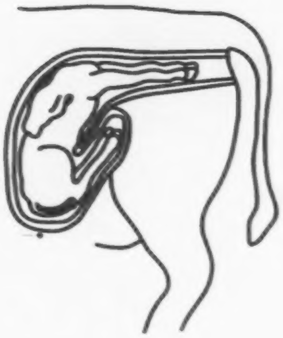

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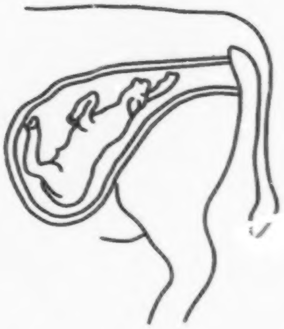

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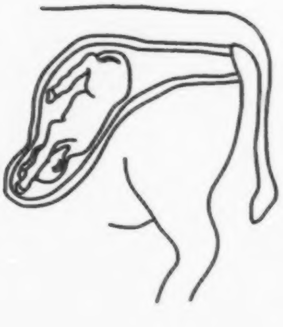
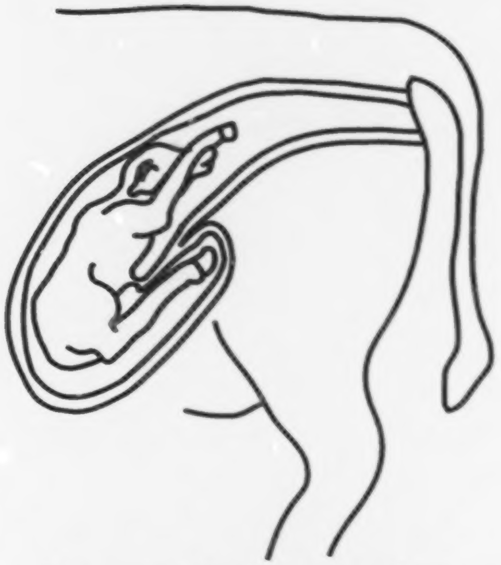
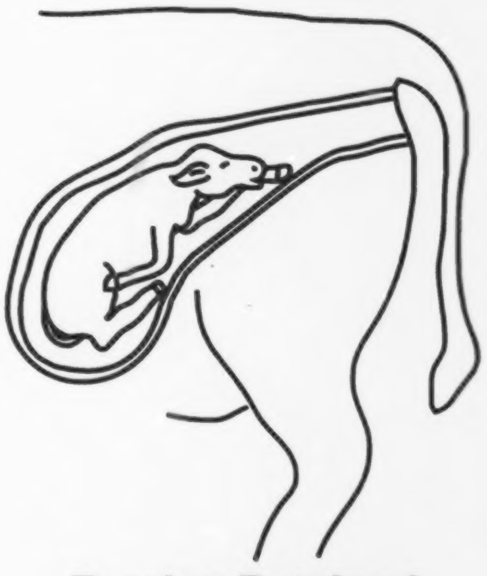


TM 5.1

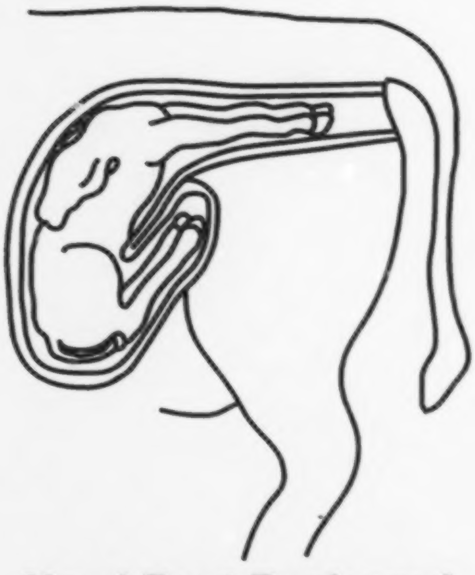
Parturition Presentations of a Calf



Normal Presentation

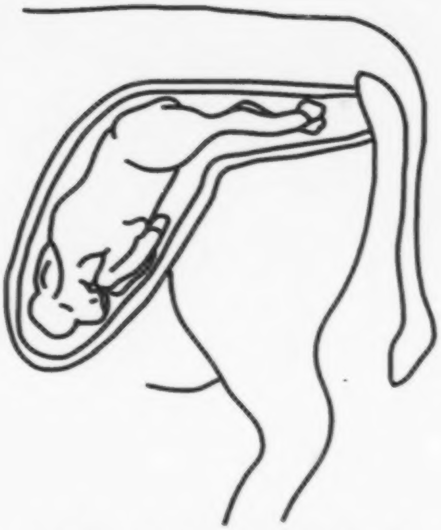


Foreleg Retained

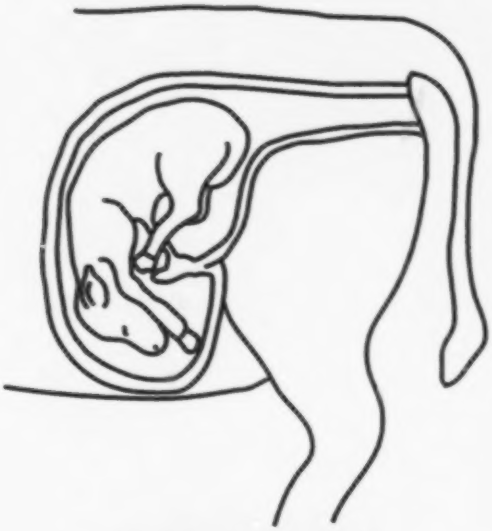


Head Bent Backward

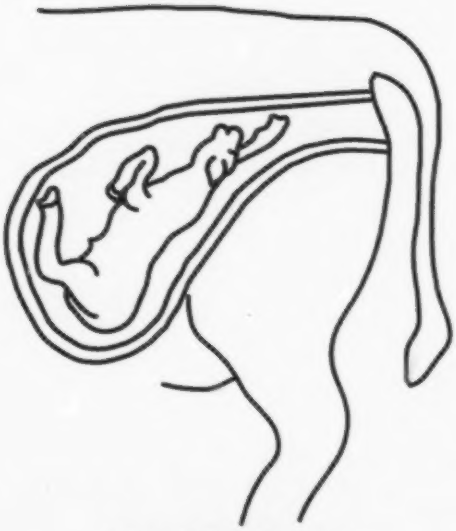
TM 5.1 (Continued)



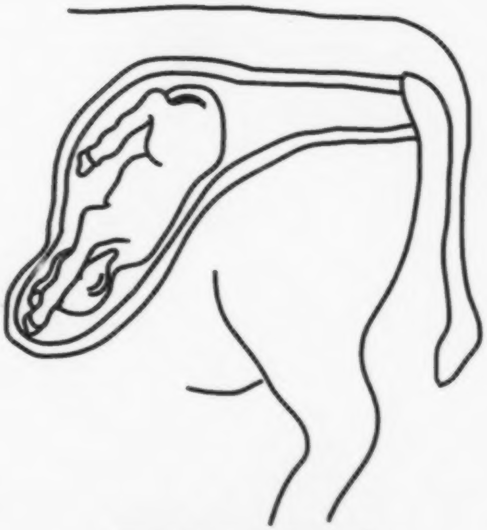
Hind Legs Extended



Backward with Feet Retained



Upside Down



Backward and Upside Down

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION AS 5.1

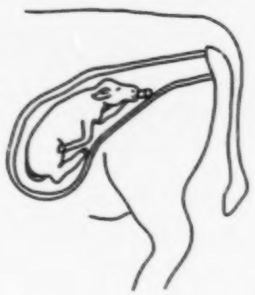
Lesson 5: Parturition Name______________________________

Handling Parturition Difficulties

Objective: Identify normal and abnormal presentations of the calf and the appropriate response to malpresentations.

Identify whether each presentation for the calf is normal or abnormal. For each malpresentation, indicate what is wrong and what type of assistance is required, if any.

1.



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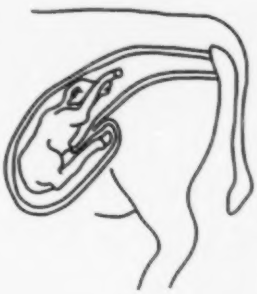
2.



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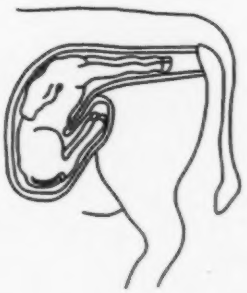
3.



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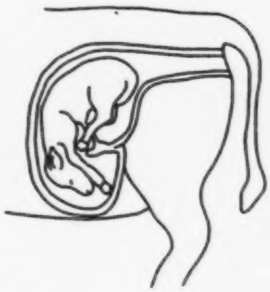
4.



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UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 6: Reproduction and Genetics

Competency/Objective: Define the role of genetics in reproduction.

Study Questions

1. **What is a gene and its function?**
2. **What is a chromosome and its function?**
3. **What is the relationship between dominant and recessive genes?**
4. **What determines the sex of the offspring?**

References

1. *Introduction to Animal Reproduction (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
2. Transparency Masters
   a) TM 6.1: Chromosomes and Genes
3. Activity Sheets
   a) AS 6.1: Determining Genetic Possibilities for Combs in Chickens

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 6: Reproduction and Genetics

TEACHING PROCEDURES

A. Review

In the last lesson, parturition and its role in reproduction was discussed. The newborn animal exhibits characteristics, like coloring, that are inherited from its parents. The instructions for these characteristics are passed on through genetic material obtained from the father and mother. In this lesson, the role of genetics in reproduction will be discussed.

B. Motivation

1. Ask students to guess what the color of the foal will be if a black mare is bred to a brown stallion. Ask what determines the foal's coat color. Discuss the role of genetics in coat color in horses (University Extension Guide 2791 may be used if needed). Give examples of possible coat colors for a foal with parents of different colors.

2. Ask students if they know why mules cannot reproduce. Point out that the cause of their sterility is genetic, since a mule is the offspring of a donkey, which has 62 chromosomes (31 pairs), and a horse, which has 64 chromosomes (32 pairs). The mule therefore has 63 chromosomes and is infertile.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students what a gene is. Describe the gene's role in reproduction.

   What is a gene and its function?

   a) Gene - unit of inheritance carrying traits inheritable by offspring through reproduction
   b) Deoxyribonucleic acid (DNA) - component of the gene that controls inheritance

2. Discuss chromosomes and their functions. Use TM 6.1 to give students an idea of what is included on a chromosome. Discuss how many chromosomes are present in each species. Compare the number of chromosome pairs present in human beings (23) to the number of pairs found in the animal species covered below.

   What is a chromosome and its function?

   a) Chromosomes are found in the nucleus of the cell. They carry the genes. Chromosomes occur in pairs.
   b) Offspring inherit one chromosome from each pair of the parent through the reproductive cells, which have single rather than paired chromosomes. Genetic material from each parent is thus combined in the offspring.
   c) The number of chromosomes varies among species.
      1) Cattle - 60 chromosomes, 30 pairs
      2) Swine - 38 chromosomes, 19 pairs

        3) Sheep - 54 chromosomes, 27 pairs
        4) Fowl (poultry) - 78 chromosomes, 39 pairs
        5) Horses - 64 chromosomes, 32 pairs
        6) Dogs - 78 chromosomes, 39 pairs
        7) Rabbits - 44 chromosomes, 22 pairs

3. Ask students what dominant means. Ask them what recessive means. Discuss the difference between the two and their relation to genes. Illustrate the dominant and recessive gene relationship in horned and polled cattle. Have students complete AS 6.1.

    What is the relationship between dominant and recessive genes?

    a) Dominant gene - gene that hides another gene's characteristic
    b) Recessive gene - gene associated with a trait that is suppressed by another gene
    c) Dominance in polled and horned genes in cattle
        1) Polled characteristic - dominant (A)
        2) Horned - recessive (a)
        3) Punnet square of Aa and Aa cross

	A	a
A	AA	Aa
a	Aa	aa

        4) Heterozygous - carrying two different genes for a characteristics (Aa); homozygous - carrying identical genes for a characteristic (AA, aa)
        5) Phenotype - animal's observable characteristics (phenotypic ratio - 3:1)
        6) Genotype - actual genetic makeup (genotypic ratio - 1:2:1)

4. Discuss how the sex of offspring is determined through genetics. Ask what the determining factor for sex in the offspring is.

    What determines the sex of the offspring?

    a) The female chromosome in most species is X, with the female chromosome pair being XX.
    b) The male chromosome is Y in most species, with the male chromosome pair being XY.
    c) The newborn's sex depends on whether the male's X or Y chromosome matches with the female's X chromosome when the egg is fertilized. The male determines the sex of offspring.
    d) In fowl, the female determines the sex. The female has two different sex chromosomes (ZW), while the male's (WW) are the same.

F. Other Activities

1. Have students examine incomplete dominance in more detail by doing a Punnet square to determine the possibilities for coat color in shorthorn cattle with a red bull and a white cow. Then have the students complete a Punnet square for a roan bull and a white cow.

2. Have students examine themselves and their parents for dominant and recessive traits. Recessive traits include the ability to roll the tongue, attached ear lobes, hitchhiker's thumb, and no hair on the middle segment of fingers.

G. Conclusion

Genes are units of inheritance that are carried on paired chromosomes. The relationship of the genes inherited by offspring determines its characteristics and sex.

H. Answers to Activity Sheets

1.

	r	r
r	rr	rr
r	rr	rr

Genotypic ratio - 4:0, phenotypic ratio - 4:0

2.

	R	R
R	RR	RR
r	Rr	Rr

Genotypic ratio - 1:1, phenotypic ratio - 4:0

I. Answers to Evaluation

1. d
2. b
3. c
4. c
5. d

6. The female contributes a X chromosome since its sex chromosome pair is XX. The male determines the sex, since its chromosome pair is XY and it can contribute either an X or a Y chromosome.

7. Genotype is the actual genetic makeup of an animal. Phenotype is the observed characteristics of the animal.

8.

	b	b
B	Bb	Bb
b	bb	bb

9. Two, two
10. 1:1 or 2:2, 1:1 or 2:2

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION Name______________________________

Lesson 6: Reproduction and Genetics Date______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is the unit of inheritance?

   a. Cell nucleus
   b. Chromosome
   c. Deoxyribonucleic acid
   d. Gene

2. What is the long, slender, threadlike structure used to carry inheritance?

   a. Cell nucleus
   b. Chromosome
   c. DNA
   d. Gene

3. A dog that has 39 chromosome pairs has ______________ chromosomes.

   a. 39
   b. 58
   c. 78
   d. 117

4. For most species, what is the normal sex chromosome combination of the male animal?

   a. XX
   b. XXY
   c. XY
   d. YY

5. What is a trait that is suppressed by another gene called?

   a. Dominant
   b. Genotype
   c. Phenotype
   d. Recessive

Complete the following short answer questions.

6. How is an offspring's sex determined in mammals?

7. What is genotype? What is phenotype?

Fill out a Punnet square to answer the following questions.

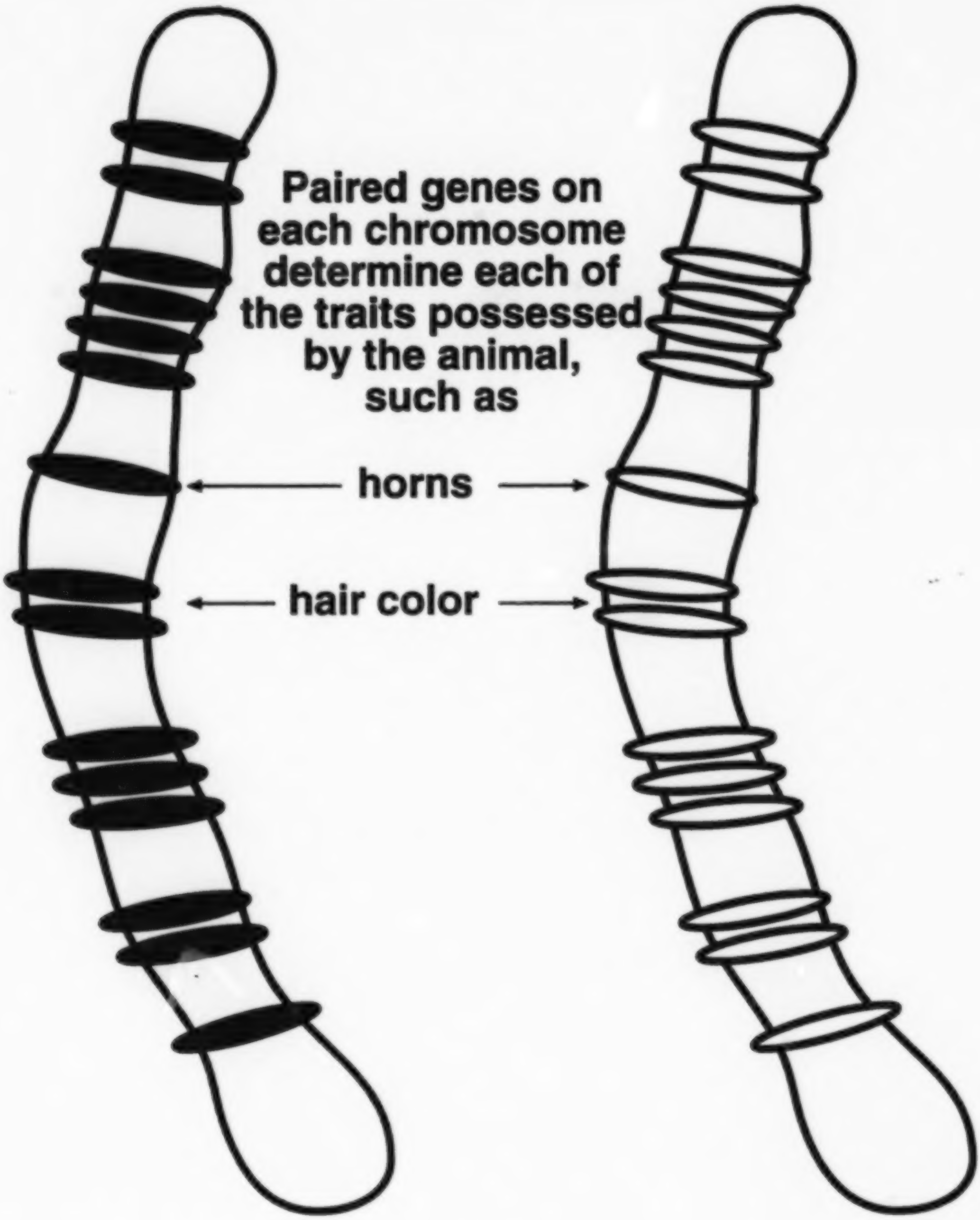
In cattle, black coat color is dominant over red. The black gene is represented with a B and the red gene with a b. A cow has a gene pair of Bb, while the bull's is bb.

8. What is the Punnet square for coat color for the offspring of the bull and cow?

9. Of the four possibilities, how many calves would be red? How many would be black?

10. What is the genotypic ratio? What is the phenotypic ratio?

Chromosomes and Genes



Paired genes on each chromosome determine each of the traits possessed by the animal, such as

horns
hair color

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION AS 6.1

Lesson 6: Reproduction and Genetics Name____________________

Determining Genetic Possibilities for Combs in Chickens

Objective: Determine the relationship between dominant and recessive genes using the Punnet square.

Fill out a Punnet square to determine the genetic possibilities for the inheritance of combs in chickens.

Key Questions:

In chickens, a rose comb is dominant and a single comb is recessive. The gene for the rose comb is represented by R, and r represents the gene for the single comb.

1. What would the offspring be if a single comb male mates with a single comb female?

What is the genotypic ratio? ____________________

What is the phenotypic ratio? ____________________

2. What would the offspring be if a rose comb male mates with a rose comb female that is known to possess the single comb gene?

What is the genotypic ratio? ____________________

What is the phenotypic ratio? ____________________

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 7: Genetic Improvement Management Practices

Competency/Objective: Compare management practices for genetic improvement.

Study Question

1. **What management practices can be used for genetic improvement?**
2. **What are various types of breeding systems?**
3. **What are the advantages and disadvantages of artificial insemination?**
4. **What are the advantages and disadvantages of embryo transfer?**

References

1. *Introduction to Animal Reproduction (Student Reference).* University of Missouri-Columbia: Instructional Materials Laboratory, 1996.
2. Activity Sheets
    a) AS 1.1: Selecting a Boar for Breeding

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION

Lesson 7: Genetic Improvement Management Practices

TEACHING PROCEDURES

A. Review

The previous lesson described the role of genetics in reproduction. The influence of genetic inheritance is evident in offspring. In this lesson, different management practices that are used by producers to help improve the genetic makeup of offspring will be discussed.

B. Motivation

Ask the students to imagine that they are showing a lamb in a market lamb show at the county fair with 20 lambs in the class. The judge places the class, and the lamb comes in 15th place. The lamb is correctly placed, since it has less muscling, size, and overall appeal than those placed ahead of it. For the county fair next year, the students want to breed a better market lamb and place higher in the class. Ask the students how they are going to improve next year's market lamb. Have the students realize that in order to have a better market lamb they need to know the various genetic improvement management practices.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students to name some genetic management practices. Describe the various practices that can be used to improve the genetics of the market lamb. Have students complete AS 7.1.

What management practices can be used for genetic improvement?

a) Genetic selection
    1) Tandem selection - selecting breeding stock for one or two traits
    2) Culling - removing less desirable traits by removing individuals with those traits from a breeding program
    3) Selection index - comparing the possible animals for breeding by using a scoring system in which the animal with the lowest number based on the criteria of the index is selected for breeding
b) Evaluation of pedigrees, individual appearances, performance records, and progeny tests (which cannot be used for a young sire)
c) Artificial insemination - improves genetics through sire selection
d) Embryo transfer - improves genetics through selection of the female

2. Ask the student what is meant by a breeding system. Discuss the responses and describe a breeding system. Describe the two main breeding systems and what they entail.

What are various types of breeding systems?

a) Straight breeding - mating animals of the same breed
    1) Purebred breeding system - both parents purebred and of the same breed

    2) Inbreeding - mating of animals that are more closely related than the average of the population using either close breeding or line breeding to improve genetic purity
    3) Outcrossing - mating of parents from the same breed but different families to bring in new traits
    4) Grading up (upgrading) - breeding of a non-registered, or grade, female to a purebred male
b) Crossbreeding - mating of two animals from different breeds
    1) Two-breed cross - mating of a male and female from two different breeds
    2) Three-breed cross - mating of a crossbred female to a male of a different breed
    3) Rotational cross - using males of different breeds for several succeeding generations of females, ending with a male of the same breed as the first female used and then repeating the series
    4) Backcrossing - mating a crossbred female to a male of one of the same breeds of the female

3. Review the procedure used in AI. Have the students write down what they think one advantage and one disadvantage of artificial insemination might be. Ask them what they wrote down and discuss the advantages and disadvantages of artificial insemination.

What are the advantages and disadvantages of artificial insemination?

a) Advantages
    1) Allows extensive use of outstanding sires to improve genetics
    2) Produces more offspring than natural mating since semen from one collection can be frozen and stored
    3) Allows injured sires to be used in a breeding program
    4) Controls diseases
    5) Makes traditional sire ownership unnecessary
    6) May lower sire costs
b) Disadvantages
    1) Requires careful handling and storage of semen
    2) Cannot refreeze semen that has been thawed, since sperm cells are destroyed
    3) Requires additional management practices and facilities and more time and labor to ensure pregnancy
    4) Requires special training to perform the procedure
    5) May overly stress females

4. Have students list some advantages and disadvantages of embryo transfer for a breeding program. Discuss the advantages and disadvantages.

What are the advantages and disadvantages of embryo transfer?

a) Advantages
    1) Allows a greater use of superior females to improve genetics
    2) Can freeze collected embryos and keep them dormant for months or years
    3) Can mechanically divide an embryo so identical twins can be produced
    4) Allows females that are unable to produce offspring themselves due to some condition to be used in a breeding program
b) Disadvantages
    1) Requires extensive management to perform
    2) Requires special management for estrous synchronization to transfer the embryo to the host female
    3) Requires the producer to keep more stock, with several recipients for every donor female, which increases costs

4) Expense of the process
5) Has a lower confirmed pregnancy rate for frozen embryos
6) May require surgery if the embryos cannot be removed from the donor female

F. Other Activities

1. Have students select the best sire for a breeding system for a cow-calf operation that raises purebred beef. Give students a cow herd and a choice between two bulls and have them select the bull for the breeding program.

2. Visit a producer who practices estrous synchronization and embryo transfer. Have him or her discuss the management practices required.

G. Conclusion

Genetic improvement management practices involve the selection or rejection of an animal for breeding based on an evaluation of the animal. Breeding systems consisting of straight breeding and crossbreeding can be used to improve the genetic makeup of offspring. Artificial breeding techniques such as AI and ET can also improve stock genetically, although their use has both advantages and disadvantages.

H. Answers to Activity Sheet

1. Leanness and the number of days to 230
2. Boar 1
3. Boar 1
4. Boar 2
5. Boar 1

I. Answers to Evaluation

1. a
2. a
3. a
4. c
5. b
6. d

7. Straight breeding is breeding animals of the same breed. The purpose is to keep purebred stock for commercial producers. Crossbreeding is the mating of two animals that are of different breeds. Many breeders use this system to attain hybrid vigor, with the offspring being superior to the average of the parents. Crossbreeding also results in animals that combine desirable traits not found in any one breed.

8. Answers should include three of each of the following advantages and disadvantages.

Advantages

- Extensive use of outstanding sires
- Storage of semen for later use
- Use of injured sires in a breeding program
- Control of diseases
- Makes traditional sire ownership unnecessary
- May lower sire costs

Disadvantages

- Difficulty of handling and storage
- Sperm cells destroyed when semen is thawed
- Additional management practices and facilities and more time and labor needed to ensure pregnancy
- Requires special training to perform the procedure correctly
- May overly stress females

9. Answers should include three of each of the following advantages and disadvantages.

Advantages

- Greater use of outstanding females
- Storage of frozen embryos for the producer's later use
- Splitting of embryos to create identical twins
- Use of superior females that have some condition that prevents them from producing their own offspring

Disadvantages

- Requires extensive management
- Necessitates special management for estrous synchronization
- Increased costs due to keeping more stock to serve as hosts for embryo transfer
- Cost of the process itself
- Low pregnancy rate when using frozen embryos
- May require surgery to extract embryos

UNIT - INTRODUCTION TO ANIMAL REPRODUCTION Name______________________

Lesson 7: Genetic Improvement Management Practices Date______________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which management practice eliminates less desirable traits by removing animals from the breeding program?
    a. Culling
    b. Embryo transfer
    c. Selection index
    d. Tandem

2. Which of the following is not used when evaluating a young sire to determine whether to include it in a breeding program?
    a. Genetic selection index
    b. Pedigree
    c. Performance record
    d. Progeny test

3. What management practice allows for the greater improvement of offspring genetics through sire selection?
    a. Artificial insemination
    b. Culling
    c. Embryo transfer
    d. Pedigree evaluation

4. What is the name of the breeding system that includes outcrossing?
    a. Crossbreeding
    b. Inbreeding
    c. Straight breeding
    d. Three-breed cross

5. What is the type of breeding used when related animals are bred to maintain a close genetic relationship to an outstanding ancestor?
    a. Closebreedng
    b. Line breeding
    c. Outcrossing
    d. Purebred

6. What is the breeding system used when a female from one breed is bred to a male of another breed?

   a. Backcrossing
   b. Hybrid vigor
   c. Three-breed cross
   d. Two-breed cross

Complete the following short answer questions.

7. What is the difference between straight breeding and crossbreeding? What is the purpose of each?

8. What are three advantages and three disadvantages of artificial insemination?

   Advantages

   a.

   b.

   c.

   Disadvantages

   d.

   e.

   f.

9. What are three advantages and three disadvantages of embryo transfer?

   Advantages

   a.

   b.

   c.

Disadvantages

d.

e.

f.

Lesson 7: Genetic Improvement Management Practices Name____________________

Selecting a Boar for Breeding

Objective: Given two boars and one sow, select a boar to improve market hog genetics.

Using the descriptions provided below, identify the sow's strengths and weaknesses in each of the three categories of breed, physical traits, and performance records. Then identify each boar's strengths and weaknesses in the three categories. Determine which breeding system to use. Match the best boar with the sow to improve market hog genetics.

Sow	Boar 1	Boar 2
Breed - Yorkshire Backfat - 0.44 inches Loin eye area - 6.45 inches Days to 230 - 165 Lean - 63.5%	Breed - Duroc Backfat - 0.44 inches Loin eye area - 5.35 inches Days to 230 - 151 Lean - 55.1%	Breed - Hampshire Backfat - 0.58 inches Loin eye area - 7.1 inches Days to 230 - 160 Lean - 61.1%

1. List the weaknesses of the sow that will be improved upon through breeding.

2. Which boar is leanest?

3. Which boar has the fewest days to 230?

4. Which boar has the largest loin eye area?

5. Which boar will be used in the breeding program?

[illegible]

Introduction To Animal Reproduction

Student Reference

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Student Reference

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FOREWORD

The development of the *Introduction to Animal Reproduction* curriculum guide is the result of suggestions by the MVATA Teaching Aids Committee. The Animal Reproduction Advisory Committee suggested the topics to be included and reviewed the materials.

This student reference contains seven lessons. Topics include the male and female reproductive systems, puberty and the estrous cycle, conception and gestation, parturition, reproduction and genetics, and genetic improvement management practices. An instructor's guide can be purchased separately.

During the summer of 1981, the Missouri State Board of Education formally adopted the concept of "Instructional Management Systems" (IMS) as a priority for the 1981-82 school year. The Missouri Commissioner of Education described the IMS concept as a practical way of "organizing for excellence" in education. To meet the demand for greater productivity and accountability, the director of Vocational Education applied the elements of IMS to form the Vocational Instructional Management System (VIMS). The VIMS process provides a framework to use in planning and organizing to assure excellence in Missouri's vocational education system by focusing greater attention on the management of teaching and learning.

The instructor's guide to accompany this student reference incorporates the needed component parts to aid agriculture teachers in the implementation of VIMS.

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INTRODUCTION TO ANIMAL REPRODUCTION

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In order for a species to thrive, it must be able to reproduce itself. Producing offspring requires the proper functioning of both the male and female reproductive systems, each of which consists of several parts that have specific purposes in the reproductive system. Hormones also play an important role in reproduction. For example, in the male reproductive system, the parts and hormones work together to produce sperm and transfer it to the female.

Parts of the Reproductive System

The male animal possesses special reproductive organs. These organs are similar in all male mammals, although some differences in form and function do exist. The bull can be used to illustrate the male mammalian reproductive system.

Bull - A bull is a male bovine. Its reproductive system contains a number of different parts (Figure 1.1). A bull has two testicles, which are located in the scrotum beneath the animal. An epididymis is located in the scrotum next to each testicle. The epididymis is connected to the urethra by the vas deferens. The seminal vesicles, prostate gland, and Cowper's gland (also called the bulbourethral gland) are located next to the bladder where the vas deferens meets the urethra. The urethra extends from this point to the penis. The sigmoid flexure is located midway along the urethra, which also has a retractor muscle attached to it. The sheath provides an opening for the penis.

Boar - A boar is a male swine. The boar's reproductive parts are pictured in Figure 1.2. One difference between the boar and the bull is the positioning of the testicles and scrotum, which are located at the rear of the boar rather than at the bottom of the animal. The form of the penis, which is shaped like a corkscrew, also differs from the bull's.

Ram - A ram is a male sheep. The ram differs from the bull in that a filiform appendage extends from the head of the penis. In the ram, the sheath is also referred to as a prepuce.

Stallion - In horses, a male is called a stallion. In contrast to the bull, the stallion's scrotum is located further toward the rear of the animal and is less

Figure 1.1 - Reproductive System of the Bull

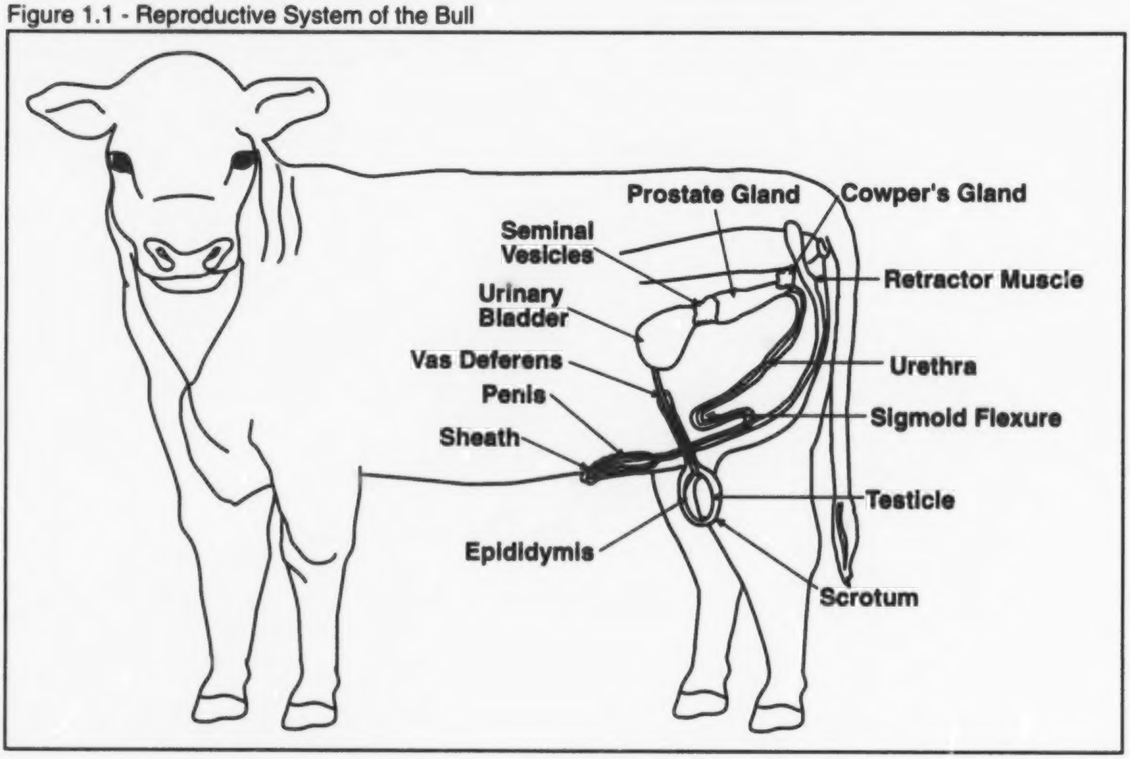
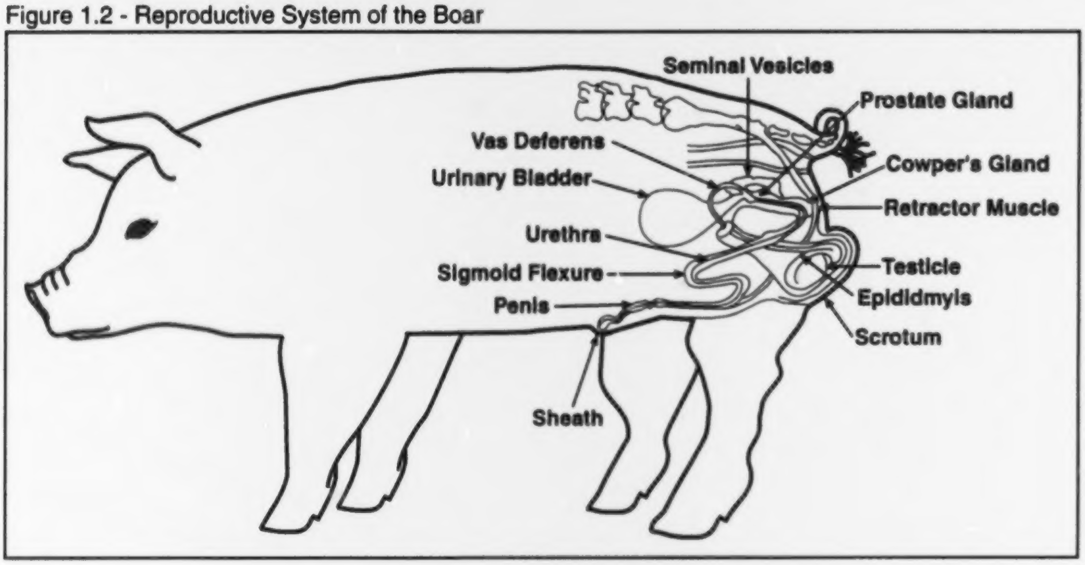


Figure 1.2 - Reproductive System of the Boar


Seminal Vesicles
Prostate Gland
Vas Deferens
Cowper's Gland
Urinary Bladder
Retractor Muscle
Urethra
Testicle
Sigmoid Flexure
Epididmyis
Penis
Scrotum
Sheath

pendulous. The stallion also lacks a sigmoid flexure.

Dog - The Cowper's gland and seminal vesicles are absent in the male dog. The dog also does not have a sigmoid flexure. The sheath of the penis is referred to as a prepuce.

Buck - The male rabbit is called a buck. Differences between the rabbit's reproductive system and the bull's include the name of the scrotum, which is referred to as the inguinal pouch, and that of the sheath, or prepuce. In the buck, the prostate gland is separated into three parts, and the Cowper's gland is absent. The buck also does not have a sigmoid flexure.

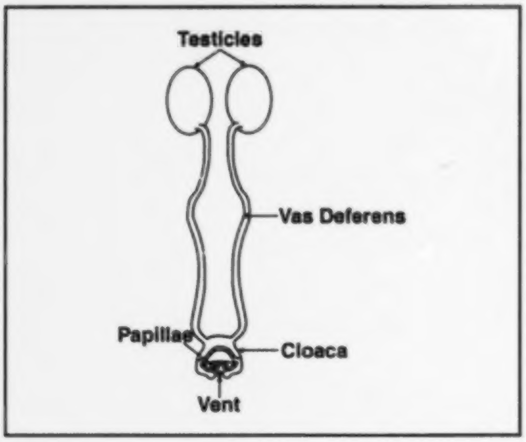
Fowl - Fowl include chickens, turkeys, and other birds. Unlike other animal species covered in this lesson, fowl are not mammals. Thus, they have a very different reproductive system from the others, as illustrated in Figure 1.3. Fowl do not have a scrotum. Instead, their testicles are located within the abdomen, next to the backbone. The vas deferens connects the testicles to the cloaca, papillae, and vent. The papillae are small, finger-like projections within the cloaca. Fowl do not have a urethra or urinary bladder.

Functions of the Parts

Each part has a specific function in the reproductive system. If any of the parts do not function correctly, the animal may have difficulty with reproduction or be unable to reproduce. A description of the functions of each of the reproductive parts of the bull is given below.

Testicles - The testicles are the primary reproductive part. They produce hormones associated with reproduction as well as the male

Figure 1.3 - Reproductive System of a Rooster


Testicles
Vas Deferens
Papillae
Cloaca
Vent

gametes, or sex cells, called sperm. The testicles are made up of seminiferous tubules, which are tiny coiled tubes that produce the sperm, as well as interstitial cells located between the tubules that secrete reproductive hormones.

Scrotum - The scrotum is a sac or pouch of skin that carries the testicles and regulates their temperature. When cold, the testicles are drawn close to the body for warmth. In hot weather the testicles hang away from the body.

Epididymis - The epididymis is a tube with three parts: a head, body, and tail. Sperm is stored in the epididymis for maturation. It also concentrates the sperm and transports it from the testicles to the vas deferens.

Vas deferens - The vas deferens is a tube that transports sperm from the epididymis to the urethra.

Urethra - The urethra carries sperm and urine to the penis.

Urinary bladder - The bladder stores urine before it is released to the urethra. It has no reproductive function.

Seminal vesicles - The seminal vesicles produce the seminal fluid that transports and protects the sperm.

Prostate gland - The prostate gland releases fluid that mixes with the seminal fluid and nourishes the sperm. The combination of the sperm with the fluids from the seminal vesicles and prostate gland is referred to as semen.

Cowper's (bulbourethral) gland - This gland releases a fluid into the urethra that cleanses and neutralizes it to allow the sperm to survive the passage to the penis. The secretions pass through the urethra prior to the semen.

Sigmoid flexure - This S-curved muscle extends the penis outside the body during mating.

Retractor muscle - This muscle pulls the penis back into the body.

Penis - The penis is an organ that deposits semen in the female reproductive tract. It also excretes urine from the body.

Sheath - The sheath is a fold of skin that covers and protects the penis when it is relaxed.

The reproductive parts found in the boar, stallion, dog, and buck have functions similar to those of the bull. The filiform appendage found in the ram is actually the opening of the urethra, which extends beyond the head of the penis. It rotates and sprays semen during mating.

The reproductive system of fowl, however, differs in form and function from the other domestic animals covered in this lesson.

Testicles - As in the other animals, sperm and hormones are produced in the testicles. In fowl, they also secrete the seminal fluid.

Vas deferens - Sperm and seminal fluid are transferred from the testicles to the cloaca through the vas deferens.

Cloaca - The reproductive and digestive systems meet at the cloaca. The male cloaca joins the female cloaca in the mating process.

Papillae - Attached to the inside wall of the cloaca, the papillae transport the sperm to the female reproductive tract during mating.

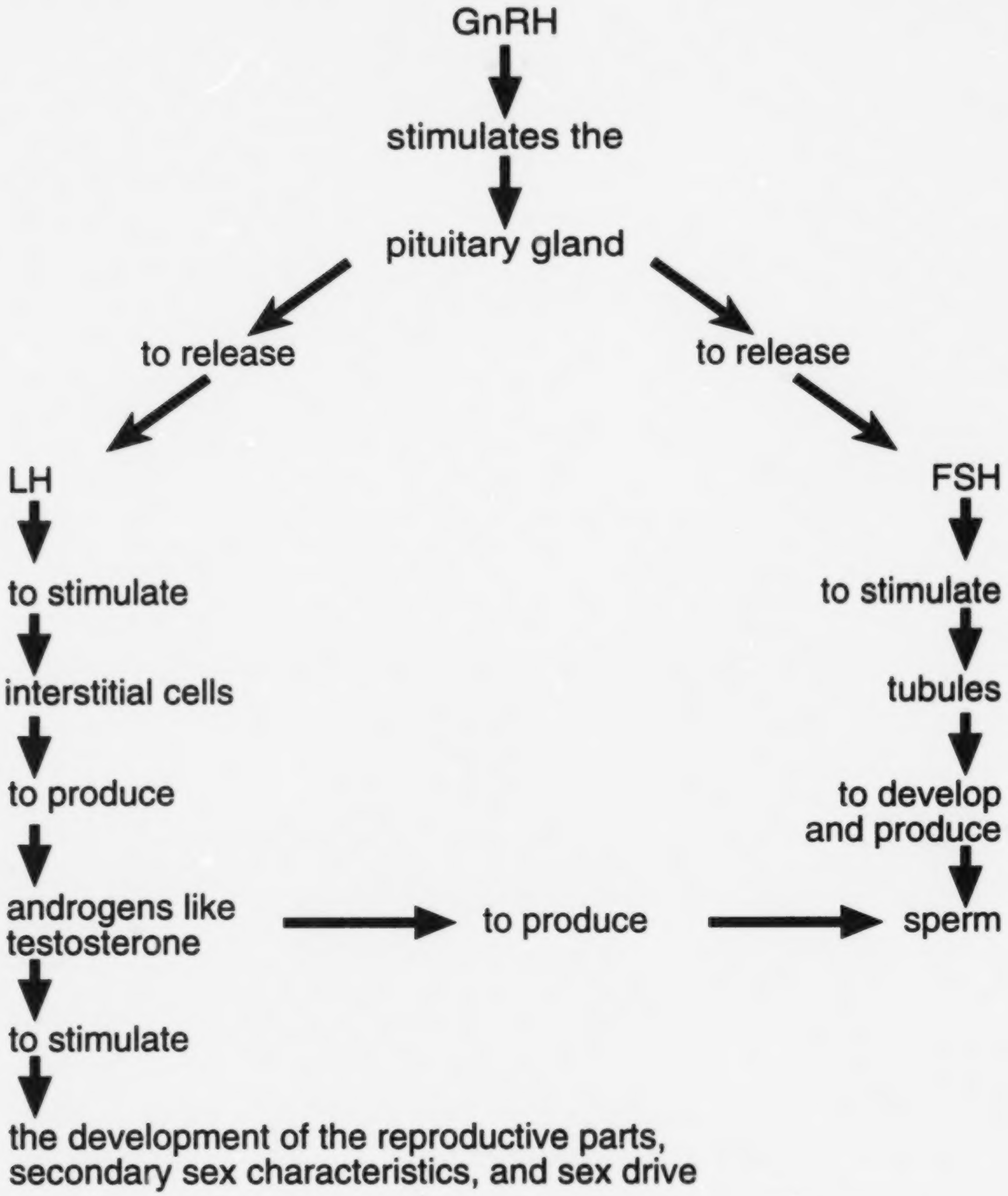
Vent - The vent is connected to the cloaca. It releases the reproductive and digestive products.

Hormones

A hormone is a chemical substance secreted by an organ of the body. When released into the bloodstream, it triggers a specific response in another organ. Reproductive hormones affect the activity of the parts of the reproductive system.

Gonadotrophin releasing hormone (GnRH) is a reproductive hormone produced by the hypothalamus gland, which is found in the brain; GnRH is not present in fowl. The anterior lobe of the pituitary gland secretes follicle stimulating hormone (FSH) as well as luteinizing hormone (LH). LH is also sometimes referred to as

Figure 1.4 - Hormones of the Male Reproductive System in Mammals


GnRH
stimulates the
pituitary gland
to release
to release
LH
FSH
to stimulate
to stimulate
interstitial cells
tubules
to produce
to develop and produce
androgens like testosterone
to produce
sperm
to stimulate
the development of the reproductive parts, secondary sex characteristics, and sex drive

interstitial cell stimulating hormone (ICSH). The sex hormones that control male reproductive development and behavior are collectively called androgens. The androgen testosterone is produced in the testicles of all the species except rabbits, which produce another androgen.

The Role of Hormones

Hormones play an important role in reproduction. A delicate balance exists among the various hormones. Figure 1.4 shows the connections between the different reproductive hormones and parts in mammals.

In mammals, GnRH stimulates the anterior pituitary gland in the brain to release both FSH and LH, which are essential to reproduction. In fowl, the release of FSH from the pituitary is stimulated by increased light. FSH affects the tubules in the testicles, causing them to produce sperm. LH causes the interstitial cells in the testicles to secrete androgens.

Androgens like testosterone stimulate the development, growth, and activity of reproductive parts. The production of androgens triggers a maturing stage called puberty, in which the reproductive parts mature as the ideal hormone level is reached. Testosterone and other androgens also trigger the development of the male secondary sex characteristics. These characteristics may include a deep voice, heavy muscling, and aggressiveness; in fowl, sex characteristics may consist of plumage, a wattle and comb, and crowing. Sex drive, which is the desire and ability to mate, is similarly stimulated by androgens. They also function in the production of sperm.

Summary

Male animals have a reproductive system that includes specific parts and hormones. Each part has a function that is triggered by the hormones of the male reproductive system.

Credits

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The female animal, like the male, has a reproductive system that consists of several different organs, as well as hormones that trigger the development and functioning of the various parts. The parts and hormones work together for the successful reproduction of healthy offspring.

Parts of the Reproductive System

The reproductive system of the female is very different from that of the male of the same species. However, all female mammals have a similar system. The reproductive system of the cow can therefore be used as a general example.

Cow - A cow is a female bovine. Its reproductive system is pictured in Figure 2.1. Two ovaries are found toward the rear of the abdominal cavity. Located next to each ovary is an infundibulum, which is the funnel-shaped portion of the oviduct. The oviducts, also known as the fallopian tubes, lead from the ovary to the uterus. The uterus consists of two branches, called uterine horns, and a body. The uterus is connected to the vagina by the cervix, the inner surface of which consists of folds of tissue. The contents of the bladder are emptied into the base of the vagina by the urethra. The external parts of the female reproductive tract are the clitoris and the vulva.

Figure 2.1 - Reproductive Parts of a Cow

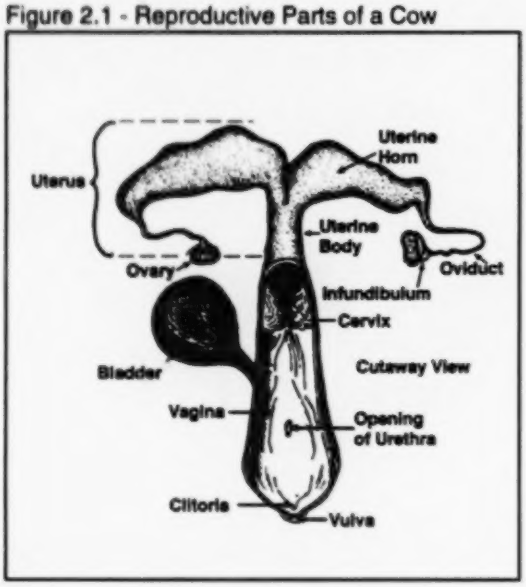
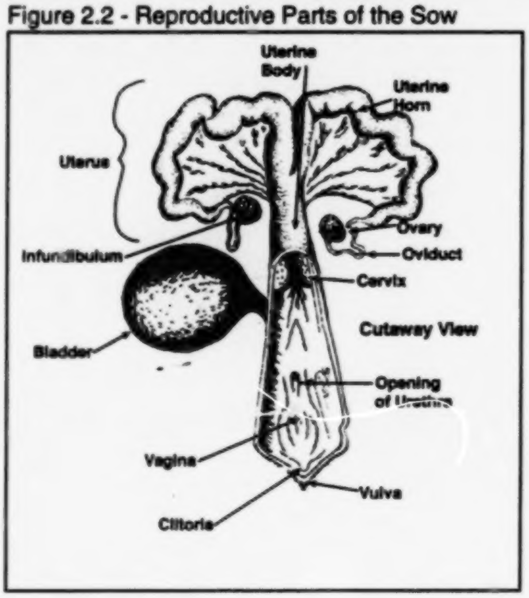

Uterine Horn
Uterus
Uterine Body
Ovary
Oviduct
Infundibulum
Cervix
Bladder
Cutaway View
Vagina
Opening of Urethra
Clitoris
Vulva

Figure 2.2 - Reproductive Parts of the Sow


Uterine Body
Uterine Horn
Uterus
Ovary
Infundibulum
Oviduct
Cervix
Cutaway View
Bladder
Opening of Urethra
Vagina
Vulva
Clitoris

Sow - A sow is a female swine. The sow's reproductive system (Figure 2.2) differs from the cow in that the uterine horns are more prominent in the sow. Also, the cervix is not folded but has protruding areas instead.

Ewe - The ewe is a female sheep. Its reproductive system is very much like the cow's.

Mare - In horses, the female is called a mare. The mare has a smoother cervix, without folds like the cow's.

Bitch - In the female dog, or bitch, the uterine horns are more prominent, like those of the sow.

Doe - The female rabbit, called a doe, has prominent uterine horns, like the sow and bitch. In the doe, each uterine horn has a separate cervix connecting it to the vagina.

Fowl - The female reproductive system in fowl is quite different from that of mammals. Figure 2.3 shows the reproductive organs of the chicken. Only the left ovary and oviduct of the hen are functional, although the right is found in an underdeveloped state. The oviduct has five parts--the infundibulum, magnum, isthmus, uterus, and

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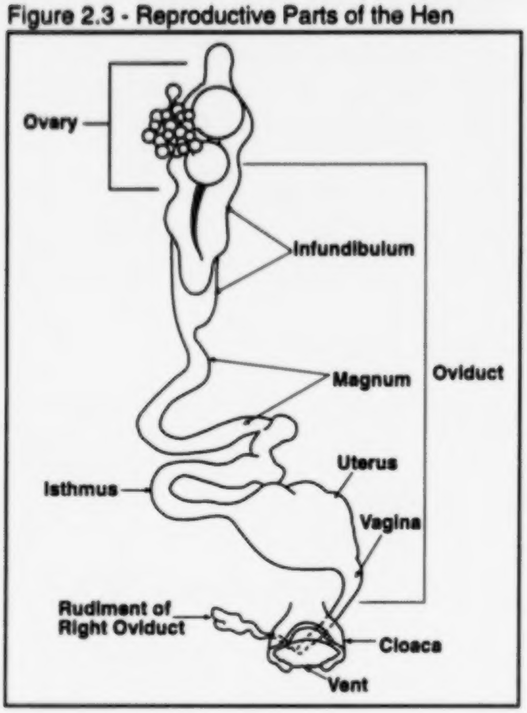
Figure 2.3 - Reproductive Parts of the Hen



the vagina. A cloaca and vent are located at the end of the oviduct.

Functions of the Parts

Each part of the female reproductive system has a very specific function. If one of the organs in the reproductive system does not function correctly, reproduction may be impaired. It may become difficult or impossible for the animal to produce healthy offspring.

Ovary - The ovaries produce the female sex cells, called eggs or ova, and sex hormones. The ova are released from follicles on the ovary.

Infundibulum - The infundibulum receives the egg from the ovary.

Oviduct - The oviduct, or fallopian tube, is a tube-like structure that carries the egg from the ovary to the uterus. It is also the site where sperm and egg meet during fertilization.

Uterus - The fertilized egg develops in the uterus before birth.

Uterine horns - The fertilized egg attaches to the uterine wall and begins to develop in the uterine horns. The sow, dog, and rabbit have more pronounced uterine horns because they are litter-bearing animals.

Cervix - The cervix is a muscular structure that functions as a passageway for the sperm and keeps bacteria and foreign material out of the uterus during pregnancy by forming a waxy mucus plug. During the birthing process, the cervix acts as a part of the birth canal.

Vagina - Semen is deposited into the reproductive system through the vagina. The vagina is a part of the birth canal as well as part of the route by which urine passes out of the body.

Urinary bladder - The bladder stores urine before it is released through the urethra.

Urethra - Urine is passed from the bladder to the vagina through the urethra. It empties into the base of the vagina. The urethra and bladder have no reproductive function.

Clitoris - The clitoris, which is located inside the vulva, is a highly sensitive part corresponding to the penis that is stimulated during mating.

Vulva - The vulva is the external opening of the urinary and reproductive systems.

The functions of the various parts of the reproductive system described above are the same for all of these species except fowl. In fowl, the reproductive parts and their functions are significantly different.

Ovary - As in the other animals discussed in this lesson, the hen's single ovary produces ova. The nucleus of the egg is attached to a yolk sac.

Oviduct - The oviduct is a long tube that transports the mature yolk from the ovary to the cloaca. It also carries semen to the infundibulum.

Infundibulum - The infundibulum receives the mature yolk from the ovary. It is also the site where the egg is fertilized by semen, which is stored in the infundibulum in the folds of the oviduct.

Magnum - The magnum secretes albumen, which is the white of the egg. It surrounds the yolk.

Isthmus - Two shell membranes are added to the egg yolk and white in the isthmus.

Uterus - Also known as the shell gland, the uterus adds a thin white, shell, and pigment to the egg.

Vagina - The egg is temporarily stored in the vagina before it is laid. It also produces the cuticle, the exterior coating of the shell.

Cloaca - The cloaca, which is the junction of the digestive and reproductive systems, receives the male's semen. The egg passes through the cloaca during laying.

Vent - The vent is the opening through which the egg passes out of the body during laying.

Hormones

Hormones are vital to reproduction. They cause the organs of the reproductive system to develop and prepare the body of the female for producing offspring.

Some of the hormones produced by females are also found in males. For example, as in the male, gonadotrophin releasing hormone (GnRH) is produced by the hypothalamus. Follicle stimulating hormone (FSH) and luteinizing hormone (LH) are also secreted from the anterior pituitary gland. Other hormones, however, are unique to the female, such as estrogen, which is secreted by the follicles in the ovary. Another hormone produced in the ovary is progesterone, which is secreted by the corpus luteum, a body that develops from a follicle that has released an ovum. The hormone prostaglandin is released by the uterus.

Fowl differ not only in the parts of the reproductive system but also in the number of hormones produced. Their bodies secrete only four major sex hormones. FSH and LH are released by the anterior pituitary gland, and estrogen and progesterone are secreted by the ovary. While these hormones are found in the other species, their functions differ in fowl.

The Role of Hormones

Hormones regulate and develop the reproductive system. The hormones must interact in a balanced manner to ensure the proper development and functioning of the reproductive system. Figure 2.4 graphically illustrates the female hormone cycle.

As it does in the male, GnRH stimulates the pituitary to release FSH and LH. In the female, FSH stimulates the follicles in the ovaries to develop a mature ovum. FSH also triggers the secretion of estrogen.

Estrogen causes the sex organs and secondary sex characteristics to develop and stimulates a desire to mate. Estrogen has an effect on other hormones as well; when estrogen is released, it suppresses the production of FSH and encourages the production of LH by the pituitary. Estrogen also causes uterine contractions that aid in transporting sperm to the oviduct to fertilize the egg.

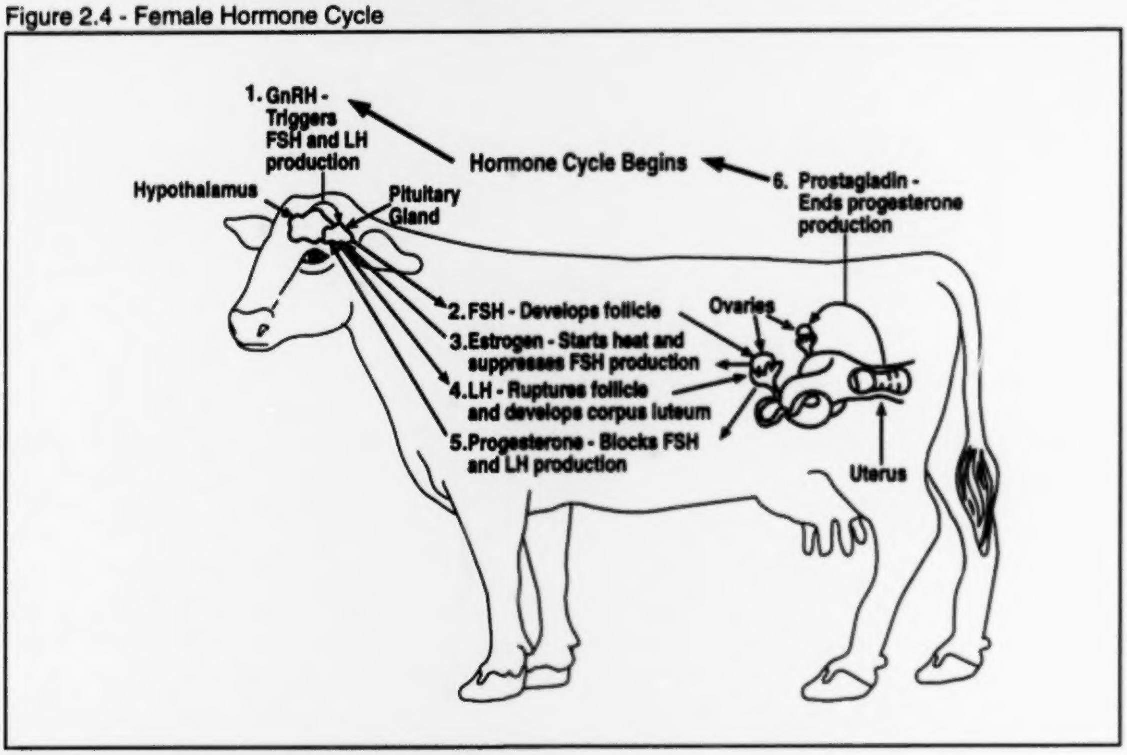
LH causes the follicle to release the egg, a process referred to as ovulation. In addition, this hormone develops the corpus luteum, also known as the yellow body, from the follicle after the egg is released.

The hormone progesterone, secreted by the corpus luteum, stops the production of FSH and LH. It thus prevents follicle development and the secretion of estrogen.

The hormones then play different roles depending on whether the egg is fertilized or not. If the egg is fertilized, the corpus luteum stays in place, and progesterone is produced to maintain the pregnancy by preventing uterine contractions and triggering the release of secretions to nourish the fertilized egg. Progesterone also blocks ovarian activity by inhibiting the secretion of GnRH. If the egg is not fertilized, the corpus luteum deteriorates due to the secretion of prostaglandin in the uterus, ending progesterone production. When progesterone levels are low, GnRH is released and the cycle starts again.

In fowl, the hormones have different roles. FSH production is triggered by increased light; for

Figure 2.4 - Female Hormone Cycle


1. GnRH - Triggers FSH and LH production
Hormone Cycle Begins
6. Prostagladin - Ends progesterone production
Hypothalamus
Pituitary Gland
2. FSH - Develops follicle
3. Estrogen - Starts heat and suppresses FSH production
4. LH - Ruptures follicle and develops corpus luteum
5. Progesterone - Blocks FSH and LH production
Ovaries
Uterus

example, lengthening spring days cause FSH to be produced in wild birds. FSH's main role is to develop yolks. It also stimulates the secretion of estrogen and progesterone. Estrogen increases blood calcium, protein, fats, vitamins, and other egg formation substances. The hormone also plays an important role in egg laying by prompting the separation of the pubic bones and the enlargement of the vent. Progesterone causes the hypothalamus to trigger LH production by the pituitary. When LH is added to the bloodstream, the follicle opens and releases the mature yolk into the infundibulum.

Summary

The various organs and hormones of the female reproductive system are important for producing healthy offspring. They work together to ensure successful reproduction.

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Animals must go through a process of sexual maturation before they are capable of producing offspring. It is important for the producer to be able to recognize when the animal has matured to the point that it is capable of reproduction. The producer also has to know when the female has entered a period of fertility and how long that period is likely to last. A lack of knowledge in these areas could be economically costly if productivity is lessened.

Puberty

Puberty is the stage of sexual maturation. In males, puberty is marked by a desire to mate and the ability to produce sperm capable of fertilizing an egg. Puberty in females involves the production of ova by the follicles, the development of the reproductive tract to give the animal the capacity to bear offspring, and a desire for mating.

While male animals are capable of breeding at any time after reaching puberty, female mammals are receptive to breeding only during specific periods, called estrus, or heat. Puberty in the female is marked by the first estrus. Therefore, it is important for breeding purposes to be able to recognize estrus.

Age of Puberty

Just as species differ in size and other characteristics, the age at which the female of each species reaches puberty varies. The age at puberty differs among individual animals within a particular species as well, dependent on factors such as nutrition, physical size, and breed. Table 3.1 shows the age at which each species reaches puberty.

In cattle, a heifer reaches puberty between six and twelve months of age; in swine, the age at which a gilt reaches puberty ranges between four to eight months. A ewe lamb becomes sexually mature between five and nine months of age. Horses reach puberty at ten to twelve months. Sexual maturity commonly occurs in dogs at any time from six to twelve months of age but varies according to breed. Rabbits usually reach puberty at five to eight months.

In contrast to these other species, fowl do not mark puberty with estrus. They do, however, pass through a period of sexual maturation in order to reproduce. For example, chickens mature sexually at 17 to 26 weeks of age. Turkeys mature later, at 27 to 30 weeks.

Estrus

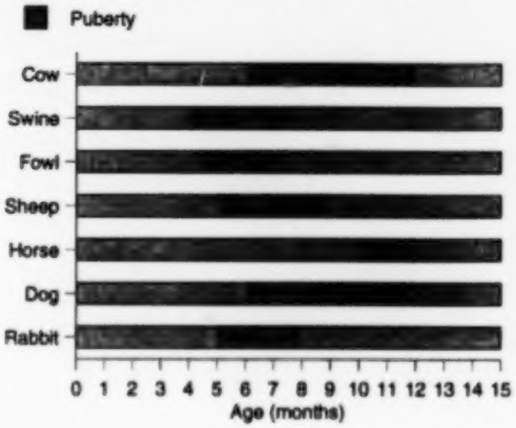
Estrus, or heat, is the period during which the female will accept the male for mating. Estrus begins at puberty and occurs at intervals during a female's life. Each interval is called an estrous cycle. The purpose of the estrous cycle is to prepare the female's reproductive tract for the release of the egg and receiving the embryo.

An estrous cycle has three phases--proestrus, estrus, and diestrus. During the proestrus phase, a follicle matures to release the egg. In the estrus phase, the female is sexually receptive to the male for mating. The egg is also released by the ovary during this phase. The last phase of the estrous cycle is diestrus. During diestrus, the reproductive tract becomes less active, until the cycle begins again with proestrus.

Variation In Estrous Cycles

Each species has a unique estrous cycle. They differ in how often estrus occurs in a year or breeding season, as well as in the length of the cycle.

Chart 3.1 - Age of Puberty in Various Species



A monoestrus animal has only one estrus in a breeding season or year. Dogs are monoestrus. They average one cycle every seven months.

Polyestrous animals are in estrus more than once a breeding season or year. Cattle, swine, sheep, horses, and rabbits are polyestrous, with estrus occurring a number of times throughout the year. Sheep and horses are different from the others in that they are seasonal breeders. In most breeds of sheep, the ewe cycles only during the fall. The time when the ewe is not cycling is called anestrus. During the breeding season, the ewe is in estrus several times. The mare usually experiences anestrus in the winter and cycles from around March until October or November. The variations in the estrous cycles of sheep and horses are triggered by changes in the length of days during the year. Decreasing daylight triggers FSH production in sheep, while increasing daylight stimulates the production of FSH in horses.

Estrous cycle lengths also differ. A cow, sow, and mare all have an average estrous cycle length of 21 days, although the ranges of possible estrous lengths vary. A cow's estrous cycle ranges between 17 and 24 days, a sow's between 18 and 24 days, and a mare's between 18 and 25 days. Sheep have an average estrous cycle length of 16 days, with a range of 14 to 20 days. Rabbits have an estrous cycle of 15 days with a range of 15 to 16 days. The length of a particular animal's estrous cycle may be altered by external factors such as the animal's environment and nutrition.

Since dogs are monoestrous, they do not have regular estrous cycles. However, they do have reproductive events, passing through anestrus and then experiencing proestrus, estrus, and diestrus once each breeding season.

Estrus Length

Estrus is the window of opportunity for mating. The timing of breeding is important, so a knowledge of estrus length is crucial. A cow has an average estrus length of 18 hours, with a range of 10 to 30 hours. The sow has a longer estrus period. A sow is in estrus for an average of 3 days, although the period can range between 1 to 5 days. A ewe has an estrus length of 30 hours, with a possible range of 22 to 38 hours. Mares are in estrus for an average of 5 days, with a range of 1 to 10 days. Estrus in dogs lasts for an average of 9 days and a range of 5 to 19 days. Rabbits do not have a well-defined estrus period, since ovulation is stimulated by the act of mating.

A comparison of estrous cycle and estrus lengths is shown in Table 3.2.

Visual Signs of Estrus

The breeder can tell whether or not the female is in estrus by looking for visual signs, such as changes in physical appearance or behavior. These signs are triggered by the production of estrogen. Some of the common visual signs for each species are listed below.

Table 3.2 - Estrous Cycle and Estrus Lengths

Species	Estrous Cycle	Estrus
Cattle	21 days (17-24 days)	18 hours (10-30 hours)
Swine	21 days (18-24 days)	3 days (1-5 days)
Sheep	16 days (14-20 days)	30 hours (22-38 hours)
Fowl	-------	-------
Horses	21 days (18-25 days)	5 days (1-10 days)
Dogs	-------	9 days (5-19 days)
Rabbits	15 days (15-16 days)	not well defined

Cow - A cow in estrus may mount other females or be willing to be mounted. The cow may be nervous or become agitated. Another visual sign of estrus in a cow is frequent urination. Also, it may have a swollen, inflamed vulva from which vaginal discharges or mucus are secreted.

Sow - A sow may show all of the same visual signs as a cow when in estrus. In addition, the sow may occasionally grunt loudly. It may also assume an immobile stance, holding its ears erect.

Ewe - In contrast to the cow and the sow, the ewe shows few signs of estrus. The ewe's vulva may be slightly enlarged and secrete mucus. The best indicator is the ewe seeking the ram and standing to be mounted.

Mare - Mares exhibit visual signs such as a raised tail and a relaxed vulva with mucus discharges. The mare may also disturb other mares, be nervous, nicker, and urinate frequently. A visual sign of estrus that is unique to the mare is the winking of the vulva. Winking is when the mare lowers her pelvis and raises her tail in a submissive manner, signaling that she is ready to mate.

Bitch - The bitch will exhibit changes in behavior in the days preceding estrus. For example, appetite may increase or decrease. In addition to behavioral changes, the vulva becomes swollen. A bloody discharge that begins during the proestrus period will cease during estrus. Another sign of estrus in the bitch is a willingness to accept the male for mating.

Doe - A doe in estrus exhibits a reddish-purple, slightly swollen vulva. It also accepts the male to mate.

Factors in First Time Breeding

An important factor in successful first time breeding is choosing the appropriate time for the female to be bred. Although a female can be bred at the first estrus, doing so is not recommended because the animal may not be physically equipped for successful reproduction. The three basic factors to consider when deciding whether an animal should be bred are physical size, age, and breed.

The physical size of the animal is important. The female should have the weight and frame size to carry the offspring for an entire pregnancy. Age also plays a role in determining when to breed. An animal should be past puberty and fully sexually mature. The breed of a particular animal should also be considered. One breed may develop faster than another breed within the same species and can therefore be bred sooner.

Local feed dealers, veterinarians, and extension livestock specialists are good sources of information about how to weigh these factors to determine the correct breeding age for a specific animal.

Summary

Puberty is the period during which animals become sexually mature. In mammals, estrus is the first indication of puberty. Each species has a different puberty age, estrous cycle and estrous cycle length, and estrus length. The producer can determine whether a female is in estrus by looking for a number of visual signs. When breeding an animal for the first time, more than the just the presence of estrus should be considered, however. Physical size, age, and breed are also important.

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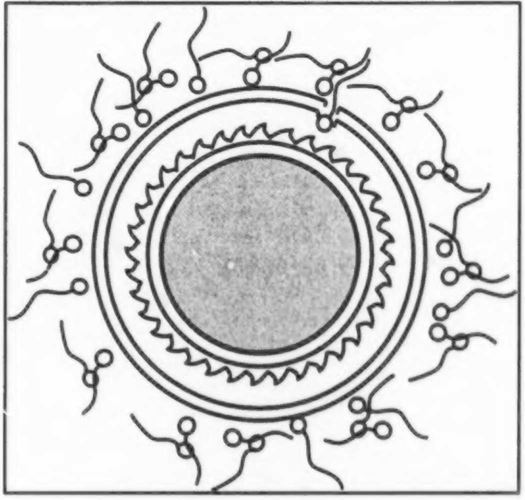
After an animal goes through puberty, it is able to produce offspring. The process of producing a new life begins with conception and continues through gestation. This lesson will discuss conception and the gestation of the fetus.

Conception

During mating, the male mammal deposits semen in the female's vagina near the cervix. The sperm travels through the cervix and the uterus into the oviduct. If an egg is present, conception occurs when the head of a single sperm penetrates the egg, which usually takes place in the upper third of the oviduct. The union of the egg and sperm (pictured in Figure 4.1) creates a new life called an embryo.

Figure 4.1 - Conception



Conception is the same in cattle, swine, sheep, dogs, and rabbits. In some of these species, however, more than one egg may be released and fertilized. The sow, bitch, and doe are all litter-bearing animals. They produce multiple ova when ovulating.

While conception is similar in fowl, some differences do exist. The male deposits semen in the cloaca. The semen then travels up the oviduct to the infundibulum, where the egg is fertilized. Fertilization takes place on the yolk at a point called the germinal disk, which contains the nucleus. In contrast to the other animals, sperm from fowl remain viable for weeks while stored in the folds of the infundibulum. Conception can therefore still occur quite some time after mating.

Methods of Impregnation

A female animal can be bred naturally or artificially. Natural breeding involves the copulation of the male and the female. Artificial methods of breeding involve human intervention in impregnation.

Two methods are used to artificially impregnate animals. One method is called artificial insemination (AI). In AI, semen is collected from the male and carefully stored to ensure the survival of the sperm. The stored semen is then ready to use when the female is in estrus. The semen is inserted into the reproductive tract using an inseminating tube (mammals) or syringe (fowl).

Another method used to artificially impregnate animals is embryo transfer (ET). In ET, injections of FSH are used to stimulate the female to ovulate many eggs. The induced eggs are fertilized either naturally or artificially. Once the eggs are fertilized, the embryos are collected from the female. Individual embryos are inserted into host females for the rest of the gestation period. ET cannot be used in fowl.

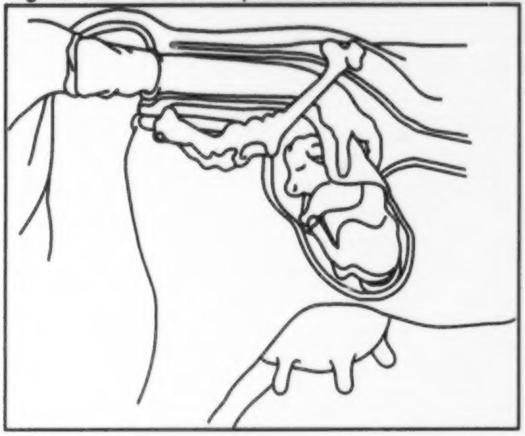
Pregnancy Determination Procedures

Being able to determine whether or not an animal is pregnant is very important. It allows the producer to make appropriate production decisions for his or her animals.

One way to determine pregnancy is by a visual inspection. If pregnant, a female will not have the visual signs of estrus. Also, the female may appear to have an enlarged abdomen later in the pregnancy.

Rectal palpation is another way to determine pregnancy. It is widely used for cattle and horses. The determination is made by feeling the uterus, as illustrated in Figure 4.2. After putting on a sterile glove to protect against infection, insert the hand into the female's rectum, which lies above the reproductive tract. Once the hand is inside the rectum and past the pelvic bones, feel for the

Figure 4.2 - Rectal Palpation in the Cow



cervix below. It should feel something like the neck of a soda bottle. After confirming the location of the cervix, extend the hand and arm to the uterus to feel for a fetus floating in the distended uterus. In the cow, button-like cotyledons, which are the points of attachment between the placenta and the uterus, may also be felt. A modified version of rectal palpation is used in sheep; a rod is inserted in the rectum and used to move the fetus so that it can be felt through the abdomen.

Abdominal palpation can also be used to determine pregnancy. It is utilized for dogs and rabbits. Abdominal palpation is actually a routine physical check, in which the abdomen is examined externally with the hands. The person doing the palpation feels for an enlarged uterus, an indication that the female is pregnant. Care should be taken when using this method to determine pregnancy, because exerting too much pressure on the abdomen could damage the embryos.

Ultrasonic sound is used for pregnancy checks for many species. The equipment necessary includes a transducer, a machine unit, and some type of sealant. The sealant is placed between the transducer and the body to exclude air. When the transducer is correctly placed, ultrasonic sound waves are transmitted through the body. The sound waves are reflected by tissue. When the waves encounter a fetus, the unit will sound or light up, indicating that the female is pregnant. Figure 4.3 shows a sow being pregnancy checked with ultrasonic sound.

Pregnancy can be determined in other ways. A laboratory may provide pregnancy results from blood tests. X-rays can be used to reveal pregnancy as well.

Gestation

Gestation is the period of development of mammalian young that begins at conception and ends at birth. Another name for gestation is pregnancy. During gestation, the fetus receives nutrients and oxygen from the mother through the placenta, the membranous tissue that surrounds the fetus in the uterus. The fetus in turn gives off carbon dioxide and waste products that are absorbed by the placenta.

Gestation can be divided into three stages, which are referred to as the cell division, embryonic, and fetal stages. The cell division stage begins right after conception. The fertilized egg undergoes 16 or more divisions while moving through the oviduct to the uterus. The cell divisions are energized by substances within the egg called cytoplasm.

The next stage is the embryonic stage. During this stage, the embryo differentiates body parts, and organs are formed. The embryo gets nourishment from the mother's uterine secretions. When the embryonic stage is complete, the fetus has been formed.

The last stage is called the fetal period. During this stage, the fetus continues to grow until birth. This stage is also known as the time of growth.

Figure 4.3 - Determining Pregnancy Using Ultrasonic Sound

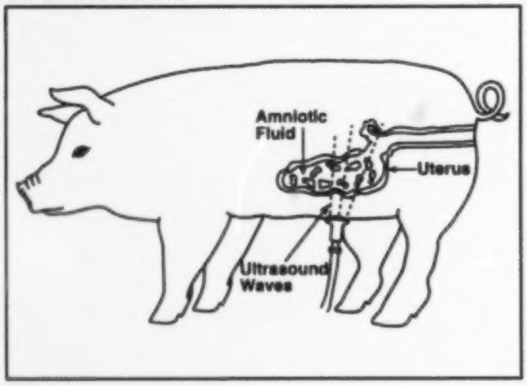
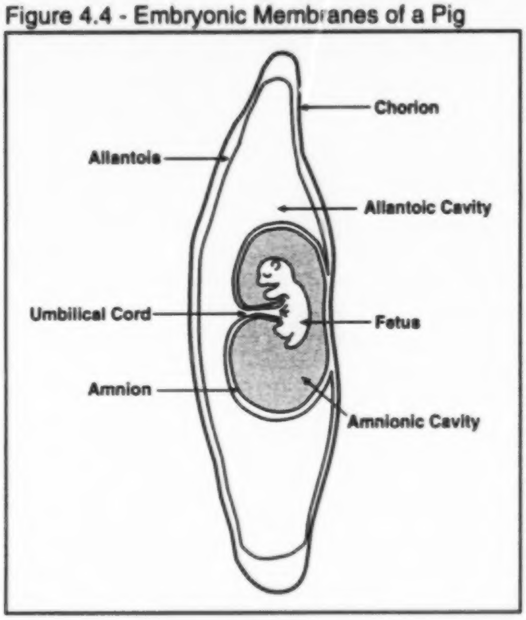


Figure 4.4 - Embryonic Membranes of a Pig



Embryonic Membranes

Three membranes form the placenta that surrounds the embryo in the uterus. These thin tissues protect and provide nourishment to the developing offspring. The embryonic membrane system is shown in Figure 4.4.

The outermost embryonic membrane is the chorion, and the innermost membrane is the amnion. The chorion is connected to the uterus. Nourishment from the mother as well as waste disposal is provided through the points where the membrane is attached to the uterus. The amnion is a sac that surrounds the embryo and contains fluid. The embryo floats within the amniotic fluid, which protects the embryo from shock. The amnion is connected to the embryo's navel by the umbilical cord, which has veins and arteries that provide nourishment for the embryo.

The third membrane is between the amnion and the chorion. This membrane is called the allantois. The allantois is an extension of the urinary system of the fetus that passes through the umbilical cord. As the pregnancy progresses, the allantois occupies more space than the other two membranes. The fluid contained within the allantoic cavity comes from the kidney of the fetus.

Factors Influencing Gestation Length

The length of gestation is often influenced by the mother's characteristics. The two most important characteristics are the mother's breed and age. Gestation length may be longer for one breed than another. The mother's age can also factor into the length of gestation; an older animal may have a shorter pregnancy. In addition, gestation length is very dependent on the individual animal. Two mothers may be of the same breed and age but still have gestation periods of different lengths.

Some other factors may also influence the length of gestation. The weather, for example, may have an effect on how long gestation lasts; extremely cold weather may trigger early delivery. The sire chosen for breeding has an effect on gestation length as well. A particular sire may consistently produce offspring with a longer or shorter gestation length than the offspring of another sire.

Incubation

Because fowl pass the fertilized egg out of the body surrounded by a protective shell, they do not experience a gestational period like that found in mammals. However, the embryo does go through a period of fetal growth called incubation that is similar to gestation. Incubation is the period from when a hen sits on an egg or it is placed in an incubator until the chick emerges at hatching. During incubation, the developing embryo is nourished by the yolk. The membranes that surround the embryo are the same as those found in mammals, although the chorion and allantois eventually merge to form the chorioallantoic membrane, which functions as a respiratory organ. Figure 4.5 is a picture of the embryo during incubation.

Figure 4.5 - Chick Embryo

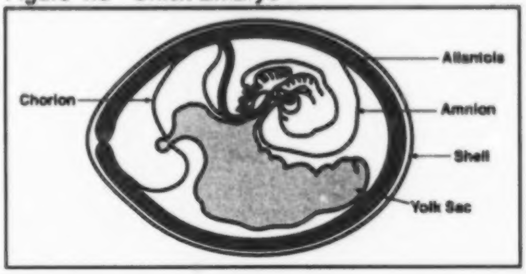


Table 4.1 - Gestation and Incubation Lengths

Species	Gestation Length	
	Average (days)	Range (days)
Cattle	281	274-290
Swine	114	112-116
Sheep	147	144-151
Horses	336	330-350
Dogs	63	56-70
Rabbits	31	30-32
Fowl (Incubation)	Chicken - 21	---
	Turkey - 28	---

Gestation and Incubation Lengths

Gestation lengths vary among species, as shown in Table 4.1. A cow has an average gestation length of 281 days, although it may range from 274 to 291 days. A sow averages 114 days, with a range of 112 to 116. The ewe's average gestation length is 147 days, with a range of 144 to 151 days. Gestation in a mare may range from 330 to 350 days, though the average is 336 days. A bitch may have a gestation length of anywhere from 56 to 70 days, with an average of 63 days. The average gestation length for a doe is 31 days, with a range of 30 to 32 days. The average length of incubation varies for different species of fowl, but the average is 21 days for chickens and 28 days for turkeys.

Summary

Conception occurs when the egg and sperm unite. This act begins the gestation or incubation period, which continues until birth or hatching. During gestation and incubation, the fertilized egg goes through several stages of development while it is protected and nourished through a system of membranes. The length of gestation varies among species as well as within a particular species.

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Gestation ends with parturition, or birth. Because both the mother and the newborn may experience a number of complications associated with parturition, it is important for a producer to be able to recognize the signs that signal that birth will soon take place, as well as problems associated with parturition. He or she will then be able to see that appropriate care is taken during and after the birth to maintain the health of both the mother and her offspring.

Parturition

Parturition is the act of giving birth. It begins after gestation has ended and is the final stage in reproduction. Hormones and mechanical factors are both at work during the birthing process.

During parturition, contractions occur to move the fetus out of the female's body. Labor involves the dilation of the cervix and the passage of the fetus and the placenta, or afterbirth. The contractions force the fetus and then the afterbirth from the uterus through the birth canal, which consists of the cervix and vagina, and then out of the body through the vulva.

Parturition is given special names when referring to different species. In cattle, for example, parturition is referred to as calving. It is called farrowing in swine, lambing in sheep, foaling in horses, whelping in dogs, and kindling in rabbits.

Physical Signs of Parturition

Certain physical signs will allow the observant producer to determine when parturition will soon occur. Some signs are common to many species, while others are unique to a particular species.

Cow - An early physical sign of parturition in the cow is a swollen udder. The hips or tail head of the cow may have a sunken appearance, and the abdominal area may be enlarged or dropped. The vulva will be swollen and reddened. As birth approaches, the female will separate from the herd and locate a place to give birth. Very close to birth, the teats will swell and leak milk. Increased mucus discharge will appear from the vulva. The cow may become restless and nervously switch back and forth from a standing to a resting position. The time of birth is near when a portion of the embryonic membranes called the water bag appears from the vulva.

Sow - Signs of approaching parturition in the sow include an enlarged abdominal area, restlessness, and attempts to build a nest. A swollen vulva and teats indicate that the sow will farrow soon.

Ewe - The first physical sign of parturition that may be observed in sheep is that the teats are swollen with milk. The vulva will swell and become slack. As lambing approaches, a mucus discharge will appear from the vulva, and the ewe will become restless, changing position by standing, lying down, and then standing again.

Mare - As in the cow, early physical signs of parturition in the mare include a swollen udder and sunken hips with a dropped abdomen. The teats will swell and a waxy substance will appear on the nipples; closer to birth the wax will disappear and milk will leak from the teats. The vulva will become swollen and relaxed. The mare will seek a spot away from other horses if possible. It may exhibit a raised tail, urinate frequently, and sweat excessively. The mare will restlessly shift from a standing to a lying position. Birth should occur soon after the water bag breaks, discharging its fluid.

Bitch - One physical sign of whelping in dogs is that the bitch will refuse meals within 24 hours of the birth. As birth approaches, the dog's body temperature will fall slightly below normal. Vomiting may also occur before whelping. A few hours before the birth, a mucus discharge will appear from the vulva.

Doe - The doe signals that birth is approaching by pulling out its fur to line its nest. It will exhibit a loss of appetite before kindling. The doe will also become nervous and excitable a few days before the birth.

Hormones and Parturition

Hormones trigger parturition. Toward the end of gestation, the corpus luteum reduces its production of progesterone. As progesterone levels in the blood decrease, the levels of the hormones estrogen, oxytocin, and relaxin increase. Relaxin is produced by the corpus luteum in most species. It relaxes the pelvic muscles, cartilage, and ligaments. The birth canal then opens due to increased levels of estrogen from the ovary. The estrogen acts together with oxytocin from the pituitary to cause contractions in the uterus.

The hormone prolactin is also produced before birth by the anterior pituitary gland. It stimulates the production of milk for the newborn.

Problems during Parturition

Because successful parturition depends on many factors, problems sometimes arise during the birthing process. These problems may be associated with either the mother or the fetus.

Some of the problems associated with parturition are due to the size of the fetus in relation to the mother's birth canal and pelvic opening. For example, a very large fetus may be too big to pass through the female's birth canal. A similar problem may occur with a normal-sized fetus if the female's pelvic opening is smaller than average. Problems with size may arise due to the selection of animals for breeding. Parturition may be difficult if a large male of a particular breed is bred to a small female of the same breed. Similar problems occur if a male of a larger breed is bred to a female of a smaller breed.

A young mother may also have difficulty with the passage of the fetus. The lack of both birthing experience and physical development is the source of the difficulty.

During the birth, damage may be done to the reproductive system. The mother can tear the cervix, vagina, and vulva. After the birth, a prolapse may occur, with the organs of the reproductive system being pulled out of the mother's body.

Other complications may also arise. The fetus may be positioned abnormally, or malpresented, which can create birthing problems. Uncontrollable fetal bleeding can be a problem if the fetus is injured during parturition. The mother or newborn may also become infected from the actual birthing process.

Malpresentations

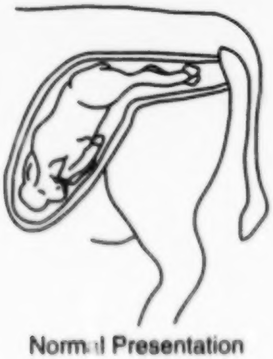
The fetus should be positioned in the uterus in order to pass through the birth canal with the least resistance. The normal presentation for cattle, sheep, horses, dogs, and rabbits is with the head positioned between the front legs to leave the birth canal first. Fetal pigs, however, do not orient themselves in any one position for birth.

Any variation from the normal position is called a malpresentation. For example, one malpresentation occurs when the fetus is positioned backward with both hind legs extended to pass into the birth canal first. While birth may proceed without assistance and occur without difficulty, the birth process must go quickly or the fetus may suffocate if the umbilical cord breaks. See Figure 5.1 for illustrations of the ideal presentation and malpresentations.

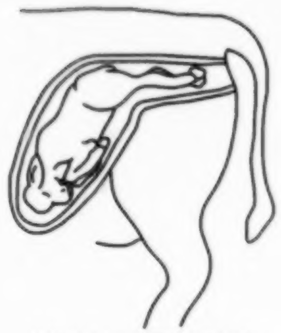
Other malpresentations require intervention in order for the birth to proceed. Often the fetus can be straightened to exit the birth canal and pulled from the mother. While some malpresentations can be corrected by the producer, many require the assistance of a veterinarian. Some of the common types of malpresentations and ways to assist with each are listed below.

1. The fetus may be turned backward with its legs retained, or bent back into the uterus. If this malpresentation occurs, straighten the hind legs to enter the birth canal. The fetus must then be delivered quickly to avoid suffocation, as explained above.
2. The fetus may be positioned to leave the birth canal headfirst but have one or both forefeet retained. If a foot is retained, pull it forward in order for the calf to exit the birth canal in the normal position.
3. The head of the fetus may be bent backward. To assist with the birth, reposition the fetus by pushing it back into the uterus and bringing the head forward between the legs. Pull the legs forward to allow the fetus to exit the birth canal.
4. The fetus may be presented abnormally by being turned upside down. Turn the

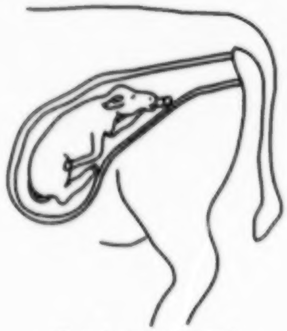
Figure 5.1 - Parturition Presentations of a Calf



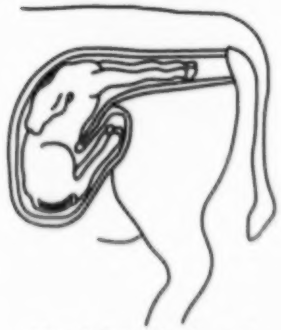
Normal Presentation



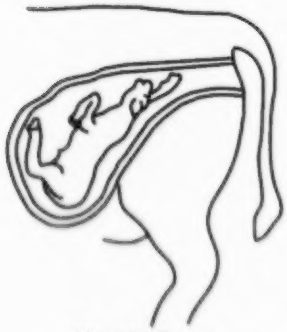
Hind Legs Extended



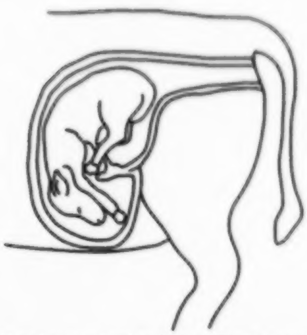
Foreleg Retained



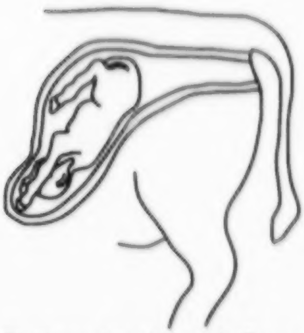
Head Bent Backward



Upside Down



Backward with Feet Retained



Backward and Upside Down

fetus to the normal position or deliver it upside down.

5. The fetus may be turned upside down and backward. Turn it to the normal position.

Occasionally, some births are so problematic that the fetus may require additional assistance. If pulling the fetus is not appropriate, a cesarean may be performed. In this procedure, a veterinarian makes an incision in the mother's abdomen to deliver the fetus.

If the fetus is no longer alive, dismemberment of the dead fetus by a veterinarian may be an alternative to remove it from the mother. Dismemberment is done to provide the least resistance for the mother.

Postpartum Management Factors

Once the birth process has been completed, the producer still has work to do. In the postpartum period, or the period that follows immediately after parturition, both the mother and the newborn need to receive care in order to ensure that they are healthy.

Cattle - Make sure that the calf is breathing properly. It may be necessary to remove mucus from the respiratory tract or provide some form of stimulation to trigger breathing. Make sure the calf has been licked dry by the mother, or dry it by rubbing it with a cloth. The newborn calf should nurse soon after birth in order to receive colostrum, a special milk secreted for only a short while after birth that passes vitamins, minerals, and antibodies to the calf; it may be necessary to hand or force feed the calf. The navel should be dipped in iodine to reduce navel infections. The calf should be identified with an ear tag. Check to make sure that the cow has expelled the afterbirth. If the placenta has been retained, serious infections can result. The cow should also be checked for signs of milk fever. Milk fever is associated with low levels of calcium in the blood and causes partial paralysis of muscles. It may appear shortly before calving and make it difficult for the cow to give birth; it may also appear after calving. Signs of milk fever are a limp tail and dragging hind feet. A veterinarian must be contacted to treat the animal with calcium injections. If untreated, the cow may become paralyzed, collapse, and die in a relatively short period of time.

Swine - Check the newborn piglet's breathing and remove mucus or provide stimulation if necessary. Dry the piglet with a cloth. Make sure that the pig nurses to receive colostrum. Remove the umbilical cord, and treat the navel with iodine. Clip the needle teeth with side cutters to protect the sow's udder. Dock the piglet's tail, and then notch the ears for identification. Make sure that the afterbirth is expelled by the sow.

Sheep - Observe the lamb's respiration. Place the lamb and its mother in a clean pen. Dry the lamb with a cloth, and make sure it is warm. It may be necessary to use heat lamps or warm water to warm the lamb, since lambs may die from becoming chilled. Check that the lamb nurses to get colostrum, and force feed if necessary. Cut the umbilical cord and treat it with iodine. Monitor the ewe to make sure the afterbirth is not retained. Check for signs of milk fever.

Horses - Check the foal's breathing. Make sure the foal nurses in order to obtain colostrum. The umbilical cord should break by itself, but if it has not broken after five minutes, it may be necessary to cut it with a pair of clean, dull scissors. However, cutting the cord may cause excessive bleeding. Once the umbilical cord has been broken or cut, dip the navel in iodine. Make sure the afterbirth is expelled within three hours; if not, call a veterinarian. The afterbirth should be closely examined to make sure the entire placenta is expelled by the mare due to the high risk of infection. Check to make sure that the foal has a bowel movement in the first 24 hours; if not, an enema may need to be administered.

Dogs - Monitor the whelp's breathing. Dry the whelp and make sure that it nurses for colostrum. Dip its navel in iodine. Make sure that the afterbirth is not retained by the bitch. The bitch also needs to be observed for a condition called eclampsis, which is caused by a calcium deficiency and occurs mostly when large litters requiring a high level of milk production are produced. If left untreated, the bitch may experience convulsions and die. Physical signs of eclampsis are panting, restlessness, whining, trembling, weakness, and fever. If these signs are observed, consult a veterinarian to obtain calcium injections.

Rabbits - Examine the new litter for 24 hours after the birth. Check the doe's nest for any dead newborns and remove them to keep the nest clean and free of infection. Also remove any afterbirth. Make sure that the newborn rabbits are nursing by examining their stomachs. Check that the nest is warm, well-drained, and well-ventilated.

Fowl and the Hatching Process

Fowl do not experience parturition, since they lay eggs instead of giving birth to young. Birds go through their own birthing process called hatching, which involves breaking through the egg's shell. In order for an egg to hatch properly, temperature, humidity, and air velocity around the egg all need to be monitored during incubation. Cool or hot temperatures, low humidity, and too low or too high a velocity of fresh air may all impair hatchability.

Like mammals, the fowl fetus may be malpresented. In fowl, the normal hatching position is with the fetus lying on its side along the longest axis of the egg. The head, which is turned to the egg's larger end, is tucked under the right wing. A malpresentation is any variation from this position.

As in the case of the young of other species, newly hatched fowl need special attention. The temperature of the brooder, which houses the young chicks, needs to be highest right after hatching. A brooder guard should be placed around the brooder for the first few days to ensure that the young birds remain where they can receive enough warmth for health and growth. Humidity and space need to be adequate, and the amount of lighting should be carefully controlled. Make sure the new fowl have proper and sufficient feed and water and are eating and drinking.

Summary

Parturition is the birth process. It is a mechanical process that occurs under the influence of hormones and is signaled by observable physical signs. A number of problems connected with the birth process may occur, including those arising from abnormal fetal presentation. After the newborn enters the world, proper postpartum management must be carried out for the mother and her young to ensure their health. Parturition does not occur in fowl, which go through the process of hatching instead, but the newly-hatched chicks also need special care to remain healthy.

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Genetics is the science of inheritance, the study of the passage of traits from one generation to its offspring. A knowledge of genetics can help the producer determine the characteristics that will likely be passed on through breeding.

Genes and Their Function

A gene is the unit of inheritance. Inheritable traits are carried to offspring during reproduction by the genes of its parents. The genes found in a particular cell determine what that cell will be like, and thus what the body made up of those cells will look like. The component of the gene that controls inheritance is deoxyribonucleic acid (DNA).

Chromosomes and Their Function

Chromosomes are long, slender, threadlike structures found in the nucleus of a cell. The chromosome carries the genes responsible for the inherited traits of the animal. Each chromosome carries hundreds of genes, which are found at a fixed location. Chromosomes occur in pairs, and thus so do genes. The genes appear side by side on the paired chromosomes. Figure 6.1 illustrates the pairing of genes and chromosomes.

Figure 6.1 - Chromosomes and Genes

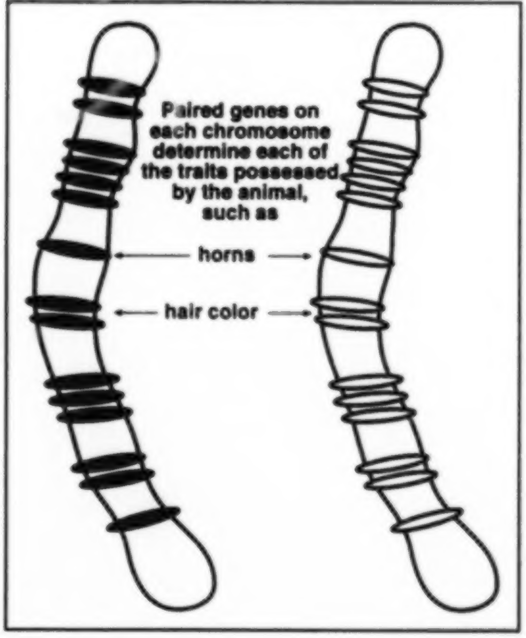
Paired genes on each chromosome determine each of the traits possessed by the animal, such as
horns
hair color

Table 6.1 - Chromosome Numbers

Species	Chromosomes	Pairs
Cattle	60	30
Swine	38	19
Fowl (poultry)	78	39
Sheep	54	27
Horses	64	32
Dogs	78	39
Rabbits	44	22

The reproductive cells (sperm and ova) are different from other cells in that they possess single rather than paired chromosomes. In human beings, for example, reproductive cells have 23 chromosomes, while other cells have 23 pairs of chromosomes. When the sperm and egg unite at conception, the fertilized egg has 23 pairs of chromosomes combining genetic material from the mother and father.

Different animal species have different numbers of chromosomes. Look at Table 6.1 to compare species. Cattle have 60 chromosomes, while swine have 38 chromosomes. The number of chromosomes found in fowl vary, but poultry have 78 chromosomes. Sheep have 54 chromosomes. A horse has 64 chromosomes, and a dog has 78. Rabbits have 44 chromosomes. To find the number of pairs, divide the number of chromosomes by two.

Dominant and Recessive Genes

Most of the traits that are expressed in offspring are determined by the combination of several gene pairs. However, some characteristics are determined by only a single pair. In that case, the interaction of the genes making up the pair can be traced, and the likelihood of whether or not an unborn animal will possess the associated trait can be calculated.

Not all of the genes inherited from its parents have a visible effect on the offspring. Some genes, called dominant genes, hide a paired gene's

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characteristic. The gene of the suppressed or hidden trait is called a recessive gene. The way in which the dominant and recessive genes match up at conception determines the trait that will be found in the offspring. Even if the gene pair has only one dominant gene, the newborn will exhibit that trait. The recessive trait will only be exhibited if the gene pair is composed of two recessive genes.

Sometimes neither of the genes in a gene pair is dominant. Incomplete dominance is the result of the joint action of the genes, both of which have an effect on the characteristic controlled by that gene pair. For example, in shorthorn cattle, the coat color may be red, white, or roan, which results from the interaction of the genes for red and white coat color.

The possible combinations of dominant and recessive gene pairs found in offspring can be predicted with a checkerboard system, which makes use of a set of boxes that form what is referred to as a Punnet square. As an example, suppose that a polled cow is to be mated to a polled bull. Horns are a recessive trait, while the polled characteristic is dominant. It is known that both cow and bull possess the recessive gene as well as the dominant one.

When recording the genetic makeup of each animal, a capital letter is used to indicate the dominant gene and a lowercase letter represents the recessive gene. In the example, a large A is used to represent the dominant polled gene and a small a indicates the recessive horned gene. The cow and bull thus each have a gene pair of Aa.

The bull's gene pair is placed on top of the Punnet square and the cow's placed on the side, one gene for each box on that side of the square. For the bull, the large A is placed over the first column and the small a over the second column, while the cow's large A is written next to the first row with the small a next to the second. Each of the boxes in the square represents a possible gene pair for the offspring. For each column and row the gene's letter is brought down or across. For example, the male has an A in the first column that is carried down the two boxes in the column. The result is four possible gene pairs of AA, Aa, Aa, and aa, as shown in Figure 6.2.

Figure 6.2 - Aa x Aa Cross

	A	a
A	AA	Aa
a	Aa	aa

According to the Punnet square, two of the offspring are heterozygous, and two are homozygous. A heterozygous animal is one that carries two different genes for a particular characteristic (Aa). A homozygous animal is one that carries identical genes for a characteristic (AA, aa).

The outward physical appearance of the animal is called the phenotype. Of the four possibilities for offspring, three will be polled, because they possess the dominant A gene. Only one of the possibilities will be horned. So the phenotypic ratio is 3:1, with three polled and one horned.

The gene pair possibilities can also be analyzed according to the actual genes found in each pair. The genetic makeup of an individual is referred to as the genotype. In the example, there are three different genotypes, with one AA, two Aa, and one aa. The genotypic ratio is 1:2:1.

Sex Determination in Offspring

Genetic inheritance also determines the sex of offspring. In most species, the X and Y chromosomes determine sex, with X being the female chromosome and Y the male chromosome. A female has a chromosome pair of XX and so can only give offspring an X chromosome. The male's chromosome pair is XY. The male therefore determines the sex of offspring, since he can contribute an X or a Y chromosome. The sex of the offspring depends on whether the X or the Y chromosome is present in the sperm that joins with the egg at conception.

In contrast, the female determines the sex in fowl. The process is the same, but the female and male roles are switched, since the female has two different chromosomes while both of the male's are the same. Figure 6.3 illustrates sex

Figure 6.3 - Sex Determination in Fowl

	W	W
Z	ZW	ZW
W	WW	WW

determination in fowl, with WW standing for the male chromosome pair and ZW for the female pair.

Summary

A gene is a unit of inheritance that is located on a chromosome. Each animal species has a specific number of chromosomes, which are found in pairs. The gene pairs on these paired chromosomes determine the characteristics of the animal, which can be passed on to its offspring through the reproductive cells. A Punnet square can be used to predict the relationship of dominant and recessive genes in offspring when the male and female are mated. Genetic inheritance determines not only the traits but also the sex of the offspring.

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Genetic improvement management practices are used to improve the genetic makeup of offspring, which leads to better quality animals. Developing a superior animal through these management practices allows the producer to achieve greater efficiency in production, since he or she has a higher quality animal.

Management Practices

Management practices that will improve a producer's stock genetically require the careful selection of animals for breeding by the producer. Genetic selection, evaluating the animal, and artificial methods of breeding are general management practices.

Genetic selection is a major management practice used to improve genetics in a breeding program. Genetic selection can be achieved using several different techniques, such as tandem selection, culling, and selection indexing.

Tandem selection involves breeding for one or two traits at a time. The selection process becomes limited and ineffective when selecting for more than two traits, because the desired traits will have less of an impact on the breeding program as more are selected. When using this technique, an individual identifies a desired trait and selects an animal possessing that trait for breeding.

Culling is a management practice that is widely used for many species. Culling eliminates less desirable traits by removing individuals possessing those traits from the breeding program. Unlike tandem selection, culling involves the removal rather than the addition of traits from the stock.

Another management practice involves using a selection index, which is a type of scoring system. Criteria are developed reflecting the desired qualities for the breeding animal. Animals are ranked for each quality, with a low score being best. The animal that has the lowest overall score based on the criteria of the index is used for the breeding program. In contrast to tandem selection, this practice considers all of the traits of the animal when selecting the best animal for the breeding program.

Evaluating animals by comparing the pedigrees (lists of an animal's ancestors), individual appearances, performance records, and progeny tests of different animals can help an individual select the proper animal for use in a breeding program. This type of management practice does not involve trying to analyze the genetics of an animal but rather evaluates its heritage and performance. For example, performance records include data on the measurable aspects of an animal's performance through its life stages that can be consulted when deciding whether or not to include it in a breeding program. Progeny tests compare sires based on the estimated performance of their offspring; they cannot be used for a young sire that has not yet produced a large number of offspring. When making improvements to a breeding program, items such as these should be considered to achieve a balanced program.

Other management practices that can be used to improve the genetic makeup of a producer's stock include artificial breeding methods. The use of these breeding methods can broaden the choices available to the producer when he or she is trying to select an animal for a breeding program. Management practices like artificial insemination (AI) and embryo transfer (ET) can be utilized after the right animal has been selected for breeding. With these techniques, the genes of exceptional males and females can be spread more extensively than they would if natural mating was used. Genetic improvement is achieved by selecting a genetically superior sire for AI or a genetically superior female for ET.

Breeding Systems

A breeding system is a system that determines the offspring's breed and its relationship to other offspring and to its parents. The two types of breeding systems are straight breeding and crossbreeding. These two systems are used in a breeding program to improve the genetic makeup of animals and the desired outcome of that program.

Straight breeding is a system that involves the mating of two animals from the same breed. Straight breeding helps to maintain a purebred stock for commercial producers, who use them in their operations to produce high quality animals. Several types of straight breeding may be utilized.

Purebred breeding is one type of straight breeding. The male and female are both purebred animals and are of the same breed. Purebred breeding results in a greater standardization of genetic material, which may at times have the negative effect of causing less desirable recessive traits to appear in the offspring.

Another type of straight breeding is inbreeding, the mating of animals that are more closely related than the average of the population. Inbreeding is used to improve genetic purity in a breeding program by further selecting for a desirable characteristic of that breed. This type of breeding is further broken down into two categories. The term close breeding is used if the relationship is a close one and the animals share more than one ancestor, such as sire and daughter or brother and sister. In another type of inbreeding, line breeding, the mating of related animals is used to maintain a close genetic relationship to an outstanding ancestor. Examples of line breeding include the mating of cousins or a female and her grandsire. This breeding system requires a careful use of selection and culling for best results.

Outcrossing involves breeding a male and female that are of the same breed but different pedigrees. The purpose of outcrossing is to bring new desirable traits into the stock.

Another method that can be used to improve genetic stock is called grading up or upgrading. In upgrading, a purebred male is bred to a grade female, which has one purebred parent and one of a mixed or unknown breed and so cannot be registered with a breed association. Grading up results in slower overall improvement, but a marked genetic improvement is present after the first breeding, clearly demonstrating the enhancements that have been made.

Crossbreeding is the other type of breeding system. It involves the breeding of two animals from different breeds; the animals may both be purebred, or a purebred male and a grade female may be bred. The major benefit of crossbreeding is hybrid vigor. Hybrid vigor is evident when the offspring displays superior qualities in comparison to the average of its parents, such an increase in size, rate of growth, and vitality. Crossbreeding also results in animals that combine desirable traits not found in any one breed. Several different crosses may be made when using the crossbreeding system.

One type of crossbreeding system is the two-breed cross. This cross involves mating a female and male from different breeds. An example of a two-breed cross is the breeding of a Hereford cow to an Angus bull.

A three-breed cross involves the mating of a crossbred female to a male of a different breed. For example, if a crossbred Angus-Hereford cow were produced by the first cross described above and bred to a Simmental bull, it would be a three-breed cross.

A rotational cross is another type of breeding system. A rotational cross involves using males of different breeds for several succeeding generations of females, ending with a male of the same breed as the female used in the first cross and then repeating the series. If the offspring of the Angus-Hereford cow from the first example and a Simmental bull was bred back to a Hereford sire, it would be a three-breed rotational cross.

Another type of crossbreeding is called backcrossing. Backcrossing involves the crossbred female being bred to a male that is of the same breed as one of the parents of the female. In the case of a backcross, the crossbred Angus-Hereford cow would be bred to an Angus or Hereford bull.

Artificial Insemination

Once a breeding system and the appropriate animals for breeding have been selected, the female can be bred either naturally or by using artificial insemination (AI). As discussed in Lesson 4, artificial insemination involves depositing semen that has been previously collected from the male in the female reproductive tract. Genetic improvement is achieved through AI by selecting the sire that best complements the breeding program.

Using AI for genetic improvement has a number of advantages.

- The biggest advantage to AI is that it allows an outstanding sire to be used more widely to improve genetics, since the sire does not need to be present for breeding. The male can therefore produce a greater number of genetically superior animals. The rate of genetic improvement for a producer's stock is increased.
- Another advantage is that AI allows the collected semen to be frozen and stored so that more offspring can be produced from one semen collection. Using AI, offspring can even be produced after the sire is dead.
- Injured sires can still produce offspring in a breeding program with the help of AI.
- AI can also be used to control diseases.
- Traditional sire ownership becomes unnecessary, eliminating associated costs.
- Sire costs may be lowered, since the producer no longer has to pay for service. However, he or she still has to pay for the services of the technician.

Artificial insemination also has some disadvantages when used as a way of improving genetic stock.

- The collected semen requires careful handling and storage. If a mistake is made when storing the semen for later use, it cannot be used to produce offspring.
- Another disadvantage concerns the thawing of semen. Once semen is thawed, it cannot be refrozen and used again, since the sperm cells are destroyed.
- AI also requires additional management practices and facilities and more time and labor to ensure pregnancy. Each use of AI requires special handling of the animal. Also, estrous cycles must be carefully monitored. Conception depends on breeding at the right time, and if insemination occurs at the wrong time, the female will not conceive and the producer will have to wait through another estrous cycle to try again.
- Since the use of proper technique is vital or conception may not occur, the person doing the procedure must be specially trained.
- A final disadvantage of using AI is that it may overly stress females.

Embryo Transfer

Embryo transfer (ET), as explained in Lesson 4, is the transferring of embryos from one female to others for the rest of the gestational period. It improves the genetic stock by allowing for the best use of the superior female that has been selected for the breeding program. ET, like AI, has its own advantages and disadvantages that should be taken into consideration when determining whether or not to use it.

Embryo transfer has several advantages for the producer.

- The greatest advantage of ET is that it allows an exceptional animal to produce a larger number of genetically superior offspring since the female yields a large number of ova for implantation. Because the female does not have to bear all her offspring herself, she can produce many more offspring during her lifetime. The rate of genetic improvement is therefore increased.
- Another advantage of ET is that the collected embryos can be frozen and remain dormant for months or years to be implanted whenever it best suits the plans of the producer.

- An embryo can be mechanically divided to produce identical twins to increase the number of superior animals.

- Superior females that cannot produce offspring themselves due to some condition may be used in a breeding program.

Disadvantages to using ET also exist.

- Extensive management is required for successful embryo transfer, since the procedure may involve the use of AI as well as the process to recover the embryos after fertilization.

- Special management is also required for estrous synchronization, or matching the estrous cycles of the donor and the host female, which is necessary in order to transfer the embryo to the host at the best time for gestation. If the timing is off, the desired offspring will not be produced.

- In order to have enough recipient females available to carry the eggs harvested from the donor female, the producer will have to keep more stock, with several recipients for every donor. Keeping more animals increases costs for the producer, with no return if the animal is unused.

- In addition to the cost of keeping additional females, ET is itself a costly process.

- Another disadvantage is the low pregnancy rate for frozen embryos implanted in surrogate mothers.

- If the procedure to remove the embryos from the donor female does not work, surgery may be required.

Summary

Genetic improvements are made through a variety of management practices. Proper management practices for breeding involve the selection of the appropriate animals and the use of a particular breeding system. When the animals to be bred and the breeding system to be used are determined, either artificial insemination or embryo transfer can be used to improve the genetic makeup of the stock owned by a producer.

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